77th Congress, 2d Session - - - - - House Document No. 892

U. S. Forest service. Southern forest experiment station.

SURVEY OF THE LITTLE TALLAHATCHIE WATERSHED IN MISSISSIPPI

LETTER

FROM THE

ACTING SECRETARY OF AGRICULTURE

TRANSMITTING

A REPORT OF A SURVEY OF THE LITTLE TALLAHATCHIE WATERSHED IN MISSISSIPPI, BASED ON AN INVESTIGATION AUTHORIZED BY THE FLOOD CONTROL ACT OF JUNE 22, 1936. THE REPORT OUTLINES A PLAN OF ACTION FOR "RUN-OFF AND WATER-FLOW RETARDATION AND SOIL-EROSION PREVENTION" IN AID OF FLOOD CONTROL

DECEMBER 2, 1942.—Referred to the Committee on Flood Control and ordered to be printed with illustrations

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1942

LETTER OF TRANSMITTAL

DEPARTMENT OF AGRICULTURE,
Washington, November 30, 1942.

The honorable the SPEAKER OF THE HOUSE OF REPRESENTATIVES.

DEAR MR. SPEAKER: Transmitted herewith is a report of a survey of the Little Tallahatchie watershed in Mississippi, based on an investigation authorized by the Flood Control Act of June 22, 1936. The report outlines a plan of action for "run-off and water-flow retardation and soil-erosion prevention" in aid of flood control.

In the estimation of the Department, a watershed-improvement plan for the Little Tallahatchie drainage is deserving of high priority among such projects. The survey reveals serious damages from flood, erosion, and sedimentation attributable in a major degree to improper land use. The improvement program recommended is designed to reduce the run-off, erosion, and flood hazards by conversions in land use and installation of remedial measures which will also improve the economic stability of the people on the land.

The total cost of installing the proposed program is estimated at $5,917,000 for the 20-year period of installation. Of this total installation cost it is estimated that the Federal Government must contribute $4,221,000; State or local governments, $472,000; and farmers and other individuals, $1,224,000. In addition to the installation costs, $417,495 of Federal funds will be needed for operation and maintenance during the installation period, and $41,695 annually thereafter.

The greater part of the cost of maintaining the program, $397,500, will be borne by private individuals.

The over-all benefits from the program are estimated to amount to $2.50 for each $1 of cost. Annual Federal costs are estimated to return a flood-control benefit of $1.48 for each $1 of cost.

The plan proposed by the Department has been integrated with that of the Corps of Engineers. There are no power developments involved in this program.

It was originally intended that the recommended programs for watershed improvement would be initiated with funds from the $4,000,000 made available to the Department for such work in Public, No. 591, Seventy-fifth Congress, approved June 11, 1938, in accordance with the authority provided in section 7 of the Flood Control Act of June 28, 1938. However, prior to the initiation of this project the Department was advised of the President's view concerning projects of this nature during the existing world crisis. The President's recommendations were subsequently incorporated in Public Law 228, Seventy-seventh Congress, the Flood Control Act of 1941. Accordingly, I am not recommending at this time an allocation of funds from the balance available under Public, No. 591, Seventy-fifth Congress, or under subsequent acts.

Although initiation of the project should be deferred until after the present emergency, the need for the program on this watershed is so great, and the cost-benefit ratio is so favorable, that it is recommended that Congress provide for carrying out the recommended program so that it may be ready for initiation when the time is opportune and funds can be made available for its installation.

The Budget Bureau advises that it has no objection to the submission of the attached report on the Little Tallahatchie watershed.

A similar letter is being sent to the President of the Senate.

Sincerely,

Paul H. Appleby,
Acting Secretary.

UNITED STATES DEPARTMENT OF AGRICULTURE
FLOOD-CONTROL-SURVEY REPORT
LITTLE TALLAHATCHIE RIVER, MISSISSIPPI

Presenting a program of watershed treatments, including measures to retard run-off and prevent soil erosion, for the control of floods on valley lands

In compliance with section 3 of the amendment (Public No. 406, 75th Congress, August 28, 1937) of the Flood Control Act of June 22, 1936 (Public No. 738, 74th Congress)

Prepared under the direction of the Forest Service
Southern Forest Experiment Station
New Orleans, La.

In cooperation with the Soil Conservation Service
and Bureau of Agricultural Economics

April 1942

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FLOOD CONTROL SURVEY REPORT, LITTLE TALLAHATCHIE RIVER, MISS.

Summary

The Little Tallahatchie River is one of four main tributaries of the Yazoo River system in northwest Mississippi and drains a watershed, upstream from the Sardis Dam and Reservoir, totaling 867,476 acres. Probably few watersheds of comparable size in this region suffer more frequent and damaging floods or offer more promising opportunities for corrective action.

Since settlement more than a century ago, the uplands have undergone serious erosion to such an extent that 294,000 acres have been forced out of cultivation, and about 75,000 acres of this are virtually ruined. Failure to employ soil- and water-conserving practices on cultivated, open, and forest lands has enormously increased surface run-off, which, together with the sediment it transports, causes excessive flood damages on 65 percent of all bottom lands. A condition has been created wherein the run-off from one-half inch of rainfall or less, converging in sediment-choked stream channels, may cause damaging floods. Floods are exceedingly frequent; in fact, a normal year witnesses about 15 of them on some small tributaries, of which 4 normally occur during the growing season and cause damage amounting to an average of $342,973 annually, principally to crops. On the average, cultivated bottom lands are annually damaged by floodwaters to an extent of about $4.20 per acre. Sedimentation damages amount to about $600,000 annually, and indirect flood damages about $238,000. Thus the total annual flood damages at present amount to approximately $1,181,000.

In spite of past abuses there remains fertile bottom land and some productive upland that can be farmed continuously with proper care and treatment. Conservation practices can markedly reduce storm run-off and almost completely eliminate erosion from cropland; trees and other permanent vegetation, supplemented by a few simple mechanical measures, can soon halt further deterioration of the open lands; and forest-improvement measures can restore the watershed-protective value of woodland cover. An upland remedial program of this sort if carried out on a comprehensive scale will reduce floods to such an extent that farmers can safely till the bottom land with reasonable assurance of growing and harvesting good crops.

The plan proposed by the Department of Agriculture as a result of this survey provides for retardation of water flow and prevention of erosion through: (1) A complete fire-control system for the watershed; (2) road-bank stabilization on 1,400 miles of State, county, and Forest Service roads; (3) treatment of all land suited for farming on a permanent basis by rotating crops, terracing slopes, treating critical

areas, developing pasture, planting trees, improving and managing farm woodlands, and controlling gullies—this work to be done by the owner with financial assistance, material, and other services contributed by the Department of Agriculture; (4) public purchase of land not suited to remain in farms and treatment of this land by planting trees, controlling gullies, and improving and managing the forests on a sustained-yield basis.

RECOMMENDED PROGRAM

A program of water-flow retardation and soil erosion prevention is recommended for the Little Tallahatchie River watershed. The sum of $4,638,000 will be required for carrying out the above-mentioned program during a 20-year period.

It is expected that the normal expenditures of the Department of Agriculture will continue to be made in the watershed under the soil conservation, agricultural adjustment, and Forest Service programs, and that these expenditures will bring about the installation of a portion of the work contemplated under this plan. Future appropriations to finance the program herein described will, of course, take account of whatever progress has been made toward installation of the program through Department expenditures under its regular programs.

Cooperation with farmers to install the program of water-flow retardation and erosion control on this watershed will be conditioned on appropriate coordination with soil conservation and the agricultural adjustment programs.

Distribution of funds.—The measures recommended and the amount of Federal and other funds required for installation of the program are as follows:

	Federal	State and local government	Private	Total
Fire protection on 577,125 acres	$80,800			$80,800
Road-bank stabilization on 1,400 miles of road	314,720	$472,080		786,800
Treatment of cultivated, pasture, and woods in agricultural area	810,470		$1,223,920	2,034,390
Land acquisition in nonagricultural area (162,880 acres)	1,091,300			1,091,300
Treatment of federally acquired land (tree planting, etc.)	959,805			959,805
Technical design and administration of program	580,000			580,000
Contingency	383,710			383,710
Total	4,220,805	472,080	1,223,920	5,916,805

In addition to the installation costs, $417,495 of Federal funds will be needed for operation and maintenance during the installation period and $41,695 annually thereafter.

Economic justification.—It is estimated that the program will yield the following average annual benefits:

Reduction of floodwater damage	$137,721
Reduction in sedimentation	132,461
Indirect flood control benefits	67,545
Conservation (on-site) benefits	825,134
Total	1,162,861

The program when fully effective will eliminate more than 25 percent of the floods that now occur on the Little Tallahatchie streams and,

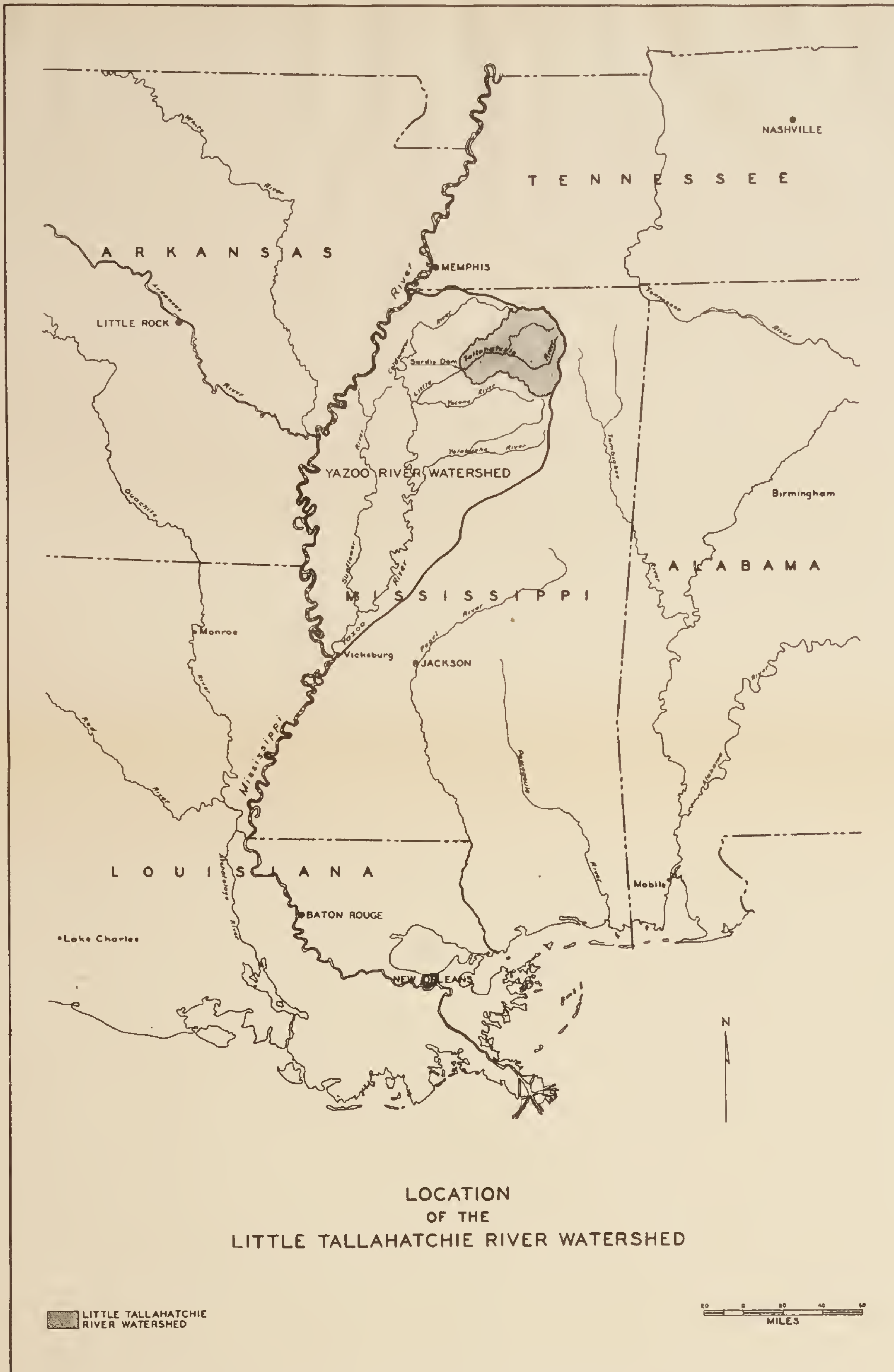

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FIGURE 1.

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in the case of the average flood, will reduce the area now inundated by about 80 percent.

The average net farm income in the watershed will be increased nearly 50 percent. Since 66 percent of the population is dependent largely on the bottom lands for income, most of the people in the watershed will receive a share of the annual flood-control benefits and practically all will receive their share of the annual benefits resulting from increased crop yields or other "on-site" additional returns. In addition to these private benefits, the program to be undertaken on the nonagricultural lands, entirely at Government expense, will yield on-site public returns valued at about $84,000 annually, besides furnishing the major part of the direct flood-control benefits. The roadbank stabilization work will yield on-site annual benefits totaling about $61,000 annually resulting from lowered road maintenance costs.

The following table gives the average annual costs and benefits of the program by subwatersheds:

Subwatershed	Annual benefits		Annual costs		Benefit per dollar of cost	Flood control benefit per dollar Federal cost
	Total	Flood control	Total	Federal		
Tallahatchie	$642,191	$181,366	$247,663	$51,068	$2.59	$3.55
Tippah	253,946	82,126	87,476	28,319	2.90	2.90
Reservoir	266,724	74,235	129,387	58,708	2.06	1.26
Total watershed	1,162,861	337,727	464,526	138,095	2.50	2.45

Although the recommended flood-control measures will require rather drastic changes in cropping practices and in the treatment and management of forest lands, the program is practical and will receive the support of the landowners and local agencies. At least 80 percent participation of landowners is expected. Unless some such program is carried out, the Little Tallahatchie watershed lands will continue to deteriorate, eventually reaching a stage where an agricultural economy is untenable. Under the proposed program, a considerable part of the uplands can be cultivated safely, the bottom lands will be flooded less frequently and with far less destruction, and farm and forest incomes will more adequately support the dependent population.

Chapter I. Description of the Watershed

GENERAL PHYSICAL DESCRIPTION

Location.

The Little Tallahatchie River is one of four principal upland tributaries of the Yazoo River system in northwest Mississippi. About 25 miles above its mouth the United States Engineer Department has constructed Sardis Dam, part of a flood-control project of four reservoirs designed to alleviate flooding in the Yazoo River Basin. This report is concerned only with the Little Tallahatchie watershed above the Sardis Dam as shown in figures 1 and 2, since this structure was designed to provide adequate flood protection for the area below it.

The watershed is fan-shaped, approximately 60 miles long and 40 miles wide, and contains a total of 1,355 square miles or 867,476 acres.[1] The Little Tallahatchie River and Tippah Creek, the only major tributary, have their former confluence obliterated by the Sardis Reservoir, and each forms a subunit of the watershed. A third subunit embraces the other small streams that empty directly into the reservoir. These three drainage areas as shown in figure 1 are hereafter referred to as the Tallahatchie tributary area (401,757 acres), the Tippah tributary area (232,426 acres), and the reservoir tributary area (233,293 acres).

Four distinct physiographic provinces or major soil areas extend north and south through the watershed. East to west they are: the Pontotoc Ridge, the Flatwoods, the Clay Hills, and the Brown Loam (fig. 1). They are quite distinctive as to soil types, erosion characteristics, vegetal cover, topography, stream and valley characteristics, degree of flood damage, and susceptibility to remedial treatment. Thus they are individual areas that require separate physical and economic studies.

Climate.

The climate of the region is mild and humid with a relatively long growing season extending from late March to early November. The mean monthly temperature ranges from 42.9° F. in January to 80.2° F. in July; extremes of 0° F. in the winter or 100° F. in the summer are rare and of short duration. During the winter, snowfall is negligible and the ground is frozen for only a few days. Precipitation, averaging approximately 50 inches annually, is ample to support a relatively luxuriant vegetation, exemplified by the prevalent deciduous forests, and is adequate for the production of agricultural crops. The minimum annual precipitation on record is approximately 34 inches; nevertheless, droughts of 6 weeks or more are not uncommon and they generally occur during the growing season.

Geology and topography.

The watershed is a rolling to hilly area in the Upper Coastal Plain, somewhat more rugged and broken in the headwater areas of the tributaries but with moderate topography throughout. Differences in elevation between valleys and uplands are small, ranging up to 300 feet. The gradients of the mature streams are nowhere excessively steep, varying from less than 5 feet per mile in the lower reaches to 20 or 30 feet per mile in the headwater areas. The soils and underlying strata are characteristic of the Gulf Coastal Plain region, the latter being composed largely of porous bedded sands and gravels interbedded with clays and marls which give the watershed as a whole an enormous capacity for water absorption and storage, but on the other hand make it exceedingly susceptible to extremely severe erosion.

The watershed lies wholly within the Mississippi embayment section of the Gulf Coastal Plain. The underlying geologic materials are, dominantly, unconsolidated, sedimentary strata of six formations varying in age from Cretaceous to Recent and are almost coterminous

[1] In this report, reference to the Little Tallahatchie watershed is used to designate the watershed above Sardis Dam. All acreage figures used in this report, unless otherwise specified, refer to the area above the Sardis Dam, exclusive of the reservoir purchase area. The total area above the dam, including the reservoir purchase area, is 963,977 acres.

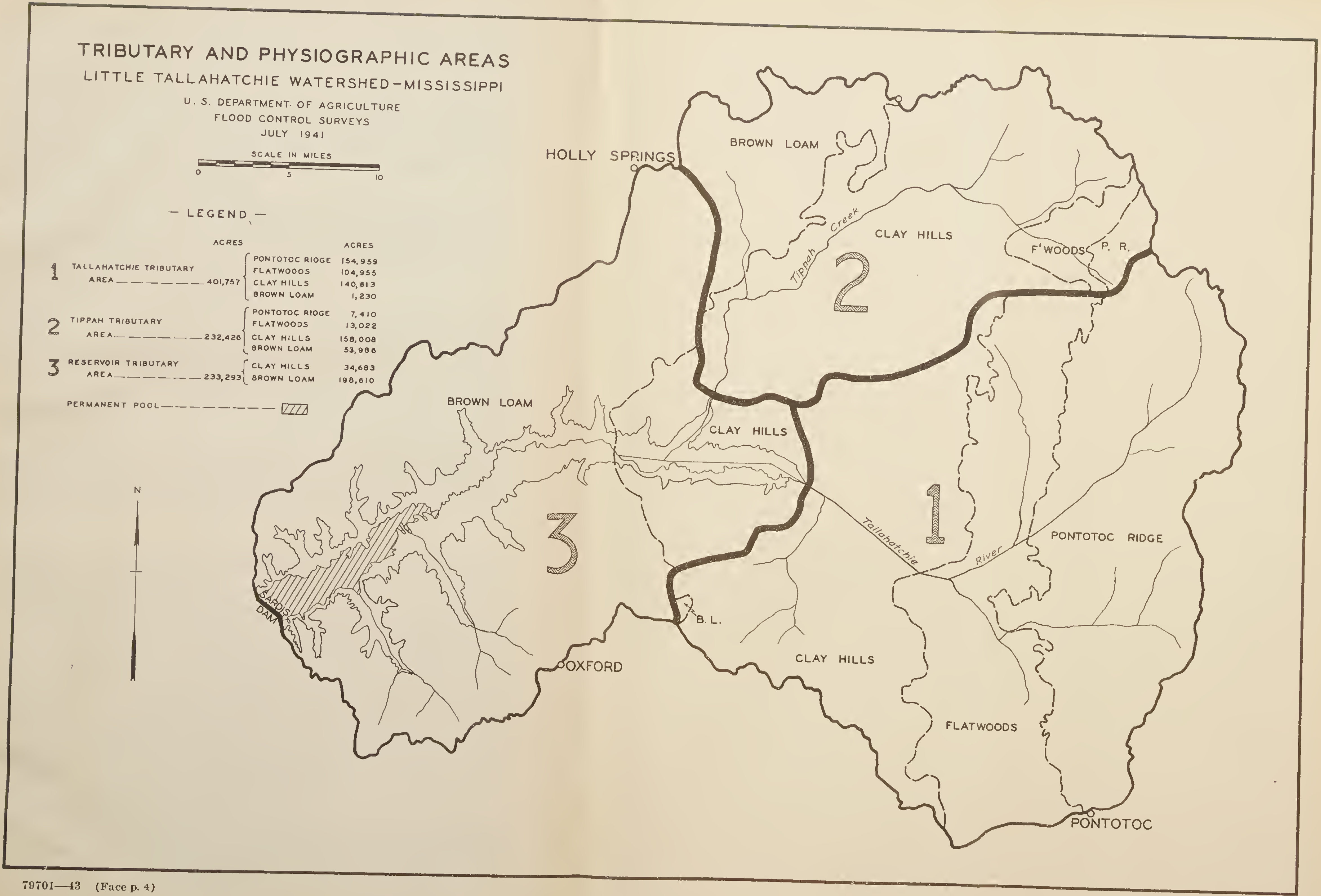

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FIGURE 2.

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with the physiographic areas (fig. 3). The dip of the strata is about 30 feet to the mile westward and outcrops of the formations strike north and south, representing successively younger formations from east to west.

Beginning on the east is the outcrop of the Ripley formation, characterized by low, steep hills of calcareous sand and sandstone containing local beds of clay. Immediately adjoining to the west is the outcrop of the Clayton formation, having similar topography but containing sandy marl overlying limestone ledges. The outcrops of the Ripley and Clayton formations constitute the physiographic area known as the Pontotoc Ridge.

The Flatwoods is coterminous with the Porters Creek clay formation with its outcrop characterized by level to gently rolling topography and by dark gray clays of rather dense and intractable nature.

Generally underlying the Clay Hills physiographic area is the Ackerman formation; the outcrop shows low rugged hills of bedded clays varying in color from lead gray to brown or reddish brown, where oxidized, and interbedded with sands.

The Brown Loam lies on outcrops of the Holly Springs and Grenada formations. The outcrop of the Holly Springs formation has rolling to hilly topography with beds of sands varying from medium to fine with interspersed beds of clay, lignite, and "ironstone." Outcrops of the Grenada formation have similar topography but are dominated by beds of lignitic clay and lignite interspersed with beds of sands and gravel. These two geologic formations are almost entirely covered by a mantle of loessal calcareous silt of Pleistocene age. The original mantle of loessal silt undoubtedly was extensive and of considerable depth. At present it covers 41 percent of the watershed and its depth decreases eastward from 12 feet on the Grenada formation to a negligible depth on the western border of the Ackerman formation, with occasional shallow deposits even as far east as the Ripley formation.

Soil and erosion.[2]

In respect to geologic origin, vegetal cover, land use, inherent productivity, and susceptibility to erosion, the soils of the watershed vary by physiographic areas.

The Pontotoc Ridge has highly productive upland and alluvial soils. The upland soils, especially in the northern and eastern parts, are relatively erodible and much land has been ruined for agricultural use. The numerous gullies are fairly shallow with firm, rounded banks and, being contiguous, give the eroded slopes a distinctive corrugated appearance (pl. 1). The west central part of the Pontotoc Ridge, consisting of about 25 square miles known locally as the Ecru area, is characterized by gently rolling to almost level topography. Although erosion is serious here, it has not been destructive and the area constitutes one of the best hill farming sections in north Mississippi. Approximately 45 percent of the physiographic area as a whole is seriously affected by severe sheet and gully erosion, and much of this land has been rendered totally unfit for crop use.

Soils in the Flatwoods are generally heavy and not as productive as those of the other areas, but local drainage has done much to improve the flood plains. Reduction of the flood hazard, accomplished by the drainage districts, has further increased their value. Although erosion

[2] See appendix, exhibits A and H, for more detailed discussions on soils and erosion, respectively. (None of the appendices are printed.)

is not severe, moderate sheet erosion is general and gullies are not infrequent.

The Clay Hills is characterized by low, steep hills and rugged topography. Although productive upland soils are found, approximately 63 percent of the area is still covered with or has reverted to forests, a condition ascribable in many cases to erosion losses resulting from farming such steep slopes. The bottom-land soils are very fertile and are extensively used for crops in spite of the high flood hazard. Erosion is very severe on the uplands that are or have been in cultivation, but does not present so great a problem in this area as in the Pontotoc Ridge and Brown Loam.

The soils of the Brown Loam have a fairly high inherent fertility, and in the few areas where erosion is not serious crop yields are good. In their present condition most Brown Loam soils are low in organic matter and many need soil building and stabilizing measures such as legumes, winter cover crops, crop rotation, and fertilizers.

Erosion in the Brown Loam is spectacular; approximately 50 percent of the area is affected by severe or extremely severe erosion. When the mantle of loess is disturbed by cultivation, fire, or overgrazing, the fine-textured soils tend to "seal over" under the impact of rainfall, thereby limiting infiltration and causing excessive run-off. When drainage channels erode through the relatively shallow loess cap, underlying sands are washed from the gullies in enormous quantities (pl. 2). These infertile sands are deposited generally on fertile bottom lands, thus causing damages in two distinct areas. Gullies from 10 to 50 feet deep are found in virtually every square mile of the Brown Loam, and almost half of the entire physiographic area has been rendered unfit for further agricultural use. The Woodson Ridge, consisting of about 8 square miles, differs from the remainder of the Brown Loam in that gentle topography prevails. However, sheet erosion is severe here and in many places very large destructive gullies are encroaching upon this, the best upland farming area in the Brown Loam.

DEVELOPMENT AND ECONOMY [3]

Agricultural development.

When white settlers began displacing the Chickasaw Indians in this watershed around 1800, they found it almost entirely in forests. Early writers refer to the dense, almost impenetrable forests; deep, clear streams; numerous springs; abundant wildlife; and fertile soils—a land not only of beauty but of plenty.

In 1834 a Government land office was established at Pontotoc, Miss., and within a few years all the land was owned by settlers or land companies. Counties were first organized in 1835. Land was rapidly being cleared for agriculture, preference being for uplands and the bench lands along streams. Corn was the important crop and was planted on half of the cleared land, while cotton occupied one-third. The remaining acreage was devoted to food crops and hay. Cotton became increasingly important as the major cash crop and in 1930 it was grown on half of the cultivated area (table 1). It did not drop back to its original place in the crop distribution until 1935,

[3] See appendix, exhibit B, for additional economic and social data.

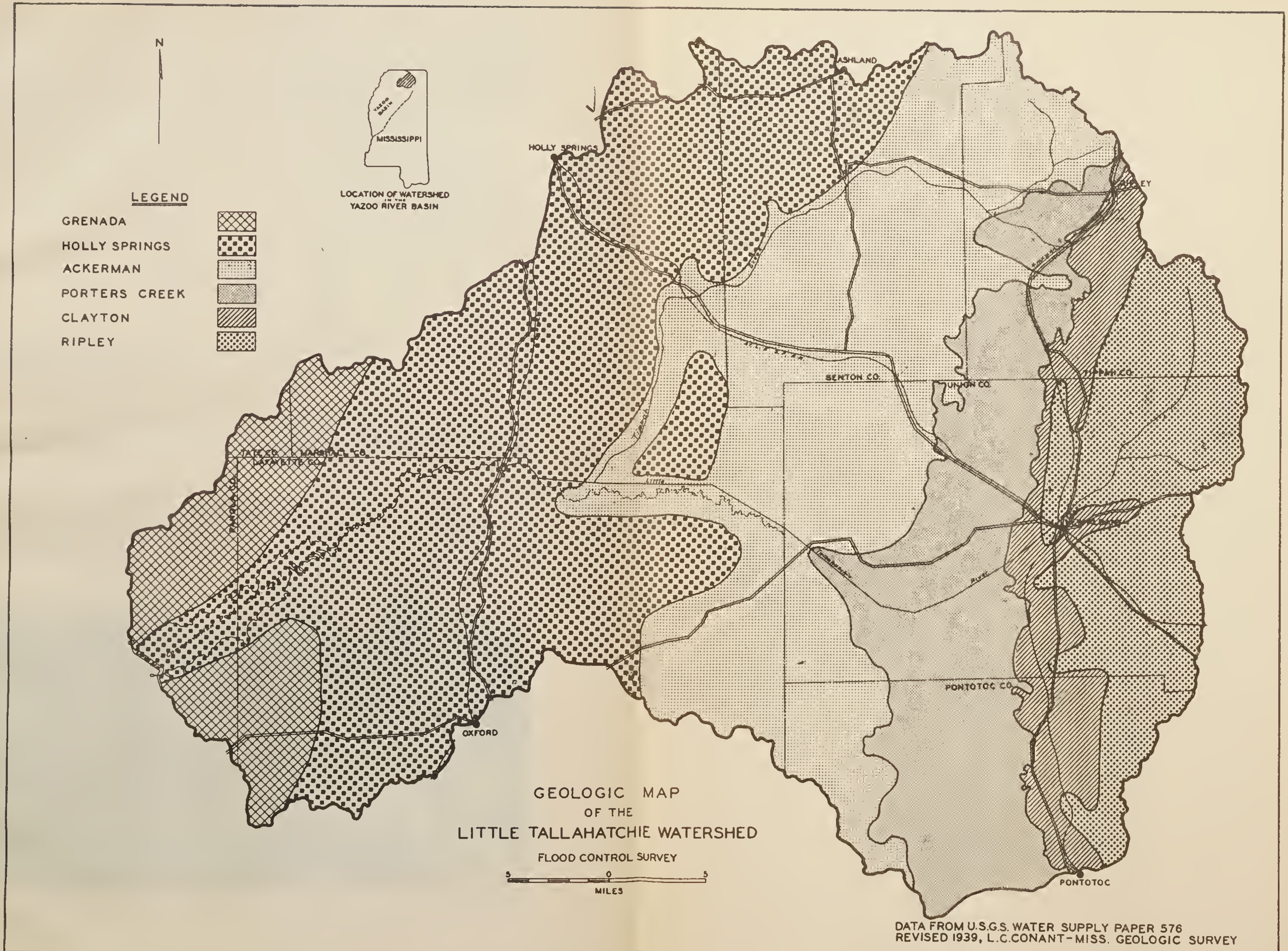

FIGURE 3

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and then only because of the cotton reduction program. Probably more important than the relative distribution of cotton and corn, both clean-tilled crops, is the fact that almost 60 percent of the watershed has been in cultivation at some time in the past, much of it planted to row crops, such as corn and cotton. This growing of clean-tilled crops without conservation measures has, indeed, been a major factor contributing to present-day flood and erosion problems.

TABLE 1.—*Distribution of crop acreages for selected years, 1850–1935* [1]

Year [2]	Cotton	Corn	Hay	Small grains	Irish potatoes	Sweet-potatoes
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1850 [3]	31.5	54.1	0.7	11.7	0.1	1.9
1860 [3]	43.6	45.3	1.8	8.1	.2	1.0
1880	45.7	45.2	.1	8.3	.1	.6
1900	46.8	48.8	2.3	1.6	.2	.3
1910	46.9	47.4	4.2	.8	.1	.6
1920	36.8	53.6	8.5	.3	.2	.6
1930	51.8	41.0	6.4	(4)	.3	.5
1935	32.8	52.4	13.4	(4)	.4	1.0

[1] Based on U. S. Census data for Benton, Lafayette, Marshall, Pontotoc, Tippah, and Union Counties.
[2] Crop acreages for the preceding year.
[3] Acreages computed by applying 1880 yields to production for 1850 and 1860.
[4] Less than 0.05 percent.

The extensive cultivation of bottom land by 1906 brought about organization of the first drainage district. In subsequent years numerous drainage districts were formed and flood-plain land began to assume more importance in the economy of the area.

PLATE 1.—Characteristic erosion in the Pontotoc Ridge Notice the sloping banks and corrugated appearance

Plate 2.—Typical Brown Loam profile, showing mantle of loess over Holly Springs sand. Notice undercutting at point of contact

Population.

The population has increased from approximately 13,200 persons in 1840 to 55,246 in 1930.[4] In 1840 about 38 percent of the population were slaves and in 1930 about 35 percent were colored; so the ratio between white and colored has changed very little over the watershed as a whole. In the Brown Loam, however, there has been a decrease in total population (about 10 percent since 1880) during recent years and an increasingly higher percentage of colored population, probably caused by increased tenancy resulting from land devastation and abandonment.

The population density is greatest in the Pontotoc Ridge and decreases slightly to the west (table 2). There are no large cities within the area, the largest town being New Albany with a population of 3,187. Although very few farms are wholly within the flood plain, approximately 28,000 persons live on farms that are principally dependent on bottom land for cash earnings.[5] This represents 66 percent of the total farm population and emphasizes the significance of bottom land as related to farm incomes.

TABLE 2.—*Total population, 1930, and number, density, and characteristics of the farm population, 1935* [1]

Physiographic area	Total population, 1930	Farm population, 1935		
		Total persons	Persons per square mile	Proportion colored
		Number		*Percent*
Pontotoc Ridge	16, 288	9, 492	37. 4	17. 3
Flatwoods	7, 796	5, 947	32. 3	20. 1
Clay Hills	16, 039	13, 201	23. 3	32. 4
Brown Loam	15, 123	14, 111	25. 1	56. 8
Total	55, 246	42, 751	27. 3	35. 4

[1] Compiled from U. S. Census Reports, 1930 and 1935.

Ownership.[6]

The greater part of the Little Tallahatchie watershed is now in private ownership. Of the total land area of 963,977 acres above the Sardis Dam, approximately 77 percent or 740,072 acres[7] is privately owned; the Federal Government owns 195,501 acres or about 20 percent, and the State owns 16,555 acres or about 2 percent. The remaining 11,849 acres or about 1 percent is in lakes, towns, rights-of-way, etc. The distribution of all ownerships, except State tax-reverted lands,[8] is shown in figure 4. All of the Federal land has been purchased since 1933.

Major uses and condition.

Approximately three-fourths of the land area of the watershed is classified by the agricultural census as land in farms[9] (table 3). Only in the Clay Hills and Brown Loam are present uses significantly different; here between 25 and 30 percent of the land has been purchased by the Federal Government for inclusion in the Holly Springs National Forest and for the Sardis Reservoir.

[4] 1940 census not available.
[5] Based on estimates of county agents and local residents.
[6] See appendix, exhibit C, for detailed data on land ownership.
[7] Of this amount, 90 percent is in possession of county residents, 8 percent is owned by individuals resident outside the county, and only 2 percent is owned by companies, etc.
[8] In 1938, State tax-reverted lands totaled approximately 15,700 ares.
[9] Exclusive of farm land in the Sardis Reservoir purchase area.

TABLE 3.—*Distribution of present major land uses*

Item	Pontotoc Ridge		Flatwoods		Clay Hills		Brown Loam		All areas	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Farms [1]	152, 438	93. 88	115, 577	97. 96	232, 171	65. 64	200, 794	60. 86	700, 980	72. 7
National forest					80, 100	22. 64	18, 900	5. 73	99, 000	10. 3
Flood control [2]					20, 401	5. 77	76, 100	23. 06	96, 501	10. 0
State park							855	. 26	855	. 1
Urban	1, 285	. 80	200	. 17	415	. 12	451	. 14	2, 351	. 2
All other [3]	8, 646	5. 32	2, 200	1. 87	20, 618	5. 83	32, 826	9. 95	64, 290	6. 7
Total area	162, 369	100. 00	117, 977	100. 00	353, 705	100. 00	329, 926	100. 00	963, 977	100. 0

[1] Based on Agricultural Adjustment Administration data for farms outside the Sardis Reservoir purchase area. There are 4,899 farms in the watershed, distributed as follows: Pontotoc Ridge, 1,347; Flatwoods, 1,099; Clay Hills, 1,452; and Brown Loam, 1,001.
[2] Sardis Reservoir purchase area.
[3] Includes roads, hunting preserves, private parks, etc.

The primary concern in the development of farm land has been to obtain the greatest immediate return with the least expenditure. This is evidenced by the fact that 28 percent of the farm land is in cultivation, clean-tilled crops occupying most of the land (table 4). In addition, 26 percent [10] of the farm land is in herbaceous vegetation or open and abandoned, much of it valueless. The remaining 46 percent is in woodlands, a large part of which have been overcut, burned, and grazed.

The cultivated land, half of which is in the uplands, is only partly protected by row crops during the growing season and is bare except for the crop stubble during the remainder of the year. Winter cover crops are seldom grown on clean-tilled areas, although this practice is coming into more extensive use, especially during the last few years.

The open and abandoned land is usually eroded, worn-out fields which support vegetal cover ranging from sparse "poverty" grass to broomsedge and scattered trees. These areas usually are burned annually to encourage the growth of grass for forage, reduce the woody type of vegetation, or for even less tenable reasons. Under such abuse, the forage consists of little more than unnutritious annual grasses and broomsedge which grow on the remnants of land between gullies and afford relatively little feed for livestock.

TABLE 4.—*Area and percent of land cover by physiographic areas*

Cover type	Physiographic areas								All areas	
	Pontotoc Ridge		Flatwoods		Clay Hills		Brown Loam			
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Woodland vegetation	49, 830	30. 7	35, 895	30. 4	209, 279	62. 7	103, 216	40. 7	398, 220	45. 9
Land covered by crops in season	64, 472	39. 7	53, 029	45. 0	70, 822	21. 3	55, 972	22. 1	244, 295	28. 2
Herbaceous vegetation largely; up to ⅓ may be covered with trees	45. 078	27. 8	27, 651	23. 4	49, 246	14. 8	91, 137	35. 8	213, 112	24. 5
Others: Lakes, towns, and rights-of-way	2, 989	1. 8	1, 402	1. 2	3, 957	1. 2	3, 501	1. 4	11, 849	1. 4
Total	162, 369	100. 0	117, 977	100. 0	333, 304	100. 0	253, 826	100. 0	867, 476	100. 0

[10] Includes rights-of-way, etc.

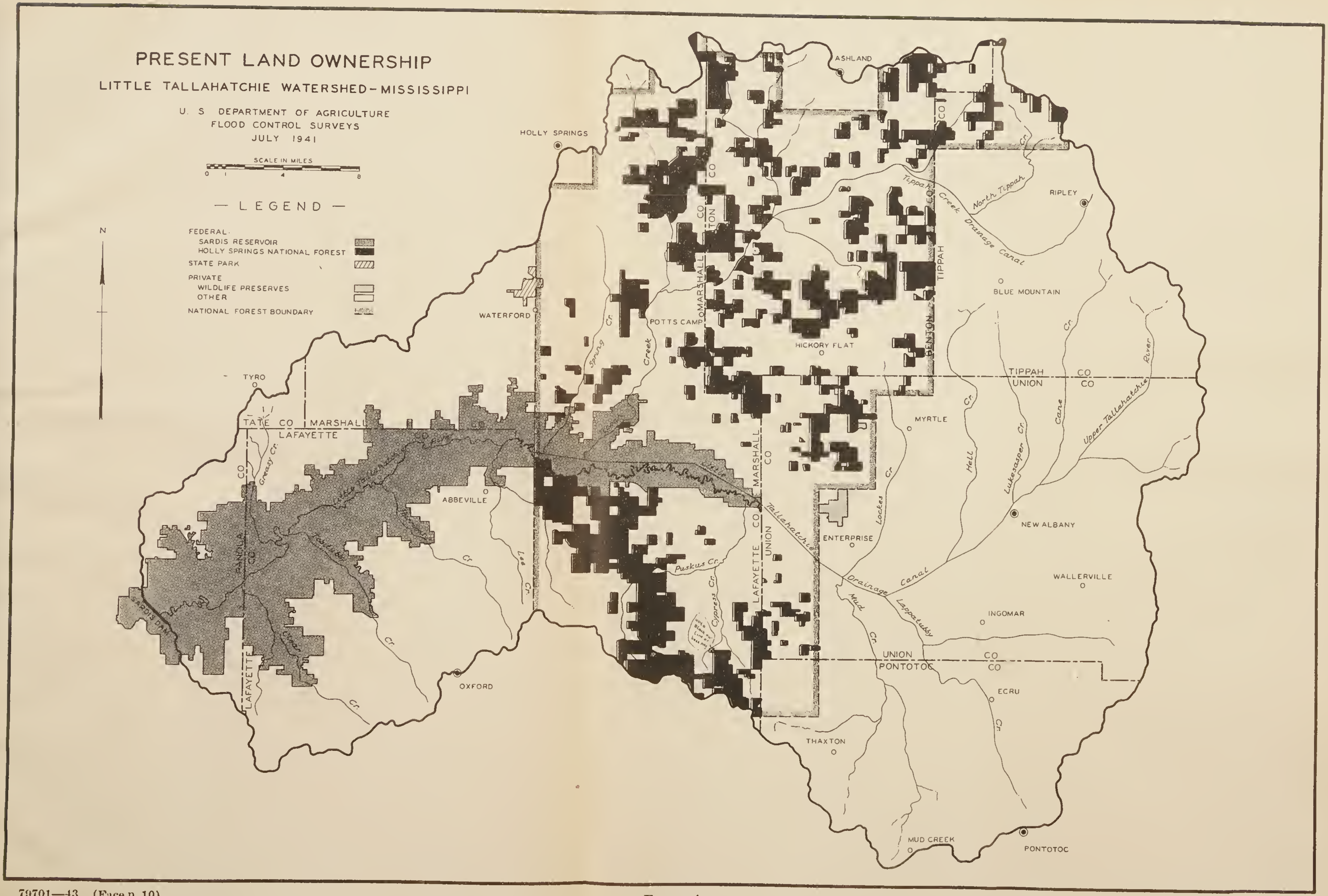

FIGURE 4.

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Most of the forests of all types are second growth, or stands of trees left by loggers.[11] Of potential commercial importance is the shortleaf pine-hardwood type, in the Clay Hills and Pontotoc Ridge, the upland hardwood type found chiefly in the loessal soils of the Brown Loam, and the bottom-land hardwood type which occurs on bottom land throughout the watershed. Since little or no proper forest management has been exercised in the watershed, the merchantable stock has been reduced to a preponderance of small, defective, or poor-quality trees of little value. Uncontrolled fires and grazing have destroyed most of the ground cover and have been partly responsible for the fact that approximately 64 percent of the forests have a stocking of less than 300 board feet per acre.

Except within recent years, no definite system of crop rotation has been practiced on cultivated farm lands in the watershed. Year after year farmers plant midseason or late corn on bottom lands, and cotton on the higher ground. Hay crops of lespedeza, soybeans, or cowpeas are planted on the poorer lands, the latter two sometimes being interplanted with corn. Winter cover crops are now being planted more extensively largely due to the influence of the crop-control and soil-conservation program of the Agricultural Adjustment Administration.

Only a small portion of the cropland is now terraced adequately. Some farmers have, however, constructed ill-designed hillside ditches that probably have increased both run-off and soil-erosion losses. Pastures also have been neglected until very recently, when improved pasture-building practices have been successfully employed on a few farms.

The Soil Conservation Service and soil-conservation district are incorporating farm-woodland management practices in their programs. While these practices are by no means widespread, they represent a step in the right direction. The prevailing cutting method on the farm woods has been to cut everything of merchantable size, and since timber is usually sold for a lump sum, the sawmill operator literally cuts every tree that will make a 2 by 4. This practice has been increasingly evident since national defense needs have stimulated the demand for low-quality material.

All farm woodlands and abandoned lands are without organized fire protection, and are subject to repeated burning. This practice reduces vegetal cover to a minimum and destroys leaf litter and other organic materials which enrich the soil and increase infiltration. In addition, overgrazing is a common maltreatment of the farm woodlands and perhaps more than any other factor prevents farm woodlands from reproducing to commercially desirable hardwood species.

Adequate protection from fire and overgrazing is provided for the national forest land, and open areas are being reforested as rapidly as funds and facilities permit in order to reduce soil and water losses. Part of the Reservoir purchase area is being leased for farm use, but the leasing arrangements make no provision for conservation practices and the area is not protected from fire.

Economic problems.

One of the major basic economic problems in this watershed is overpopulation. This might appear strange if considered from a standpoint of persons per square mile of total area (27.3 for the water-

[11] See appendix, exhibit D, for detailed description of forest stands

shed), but an analysis of land use indicates that farm income is derived largely from only about 28 percent of the area. From this standpoint the population density per square mile of cropland amounts to 112 persons. In the early development of the watershed this problem was not so acute because the exploitation of timber and soil resources furnished sufficient cash income to offset population pressure.

Under present conditions, with most of the timber resources liquidated, thousands of acres idle and abandoned, and flood damage becoming increasingly severe, the only result must be a shift in population or a lower standard of living. Some depopulation has occurred in the most seriously affected areas but the primary result has been a rapidly declining standard of living in most parts of the watershed. This lowered standard of living, in turn, forces the continuation of the row-crop and cotton economy which is a major contributing factor to present flood problems.

The high percentage of tenancy, together with the prevailing system of row-crop farming, has done much to aggravate flood and erosion problems. Slightly more than half the farmers in the watershed are nonmanaging tenants (table 5). In addition, a considerable number of farms classified as "owner-operated" are in reality operated by tenants, the owners merely signing the Agricultural Adjustment Administration worksheets. Furthermore, 86 percent of the farms were classified as cotton farms in 1930.

Table 5.—*Tenure distribution of farmers, 1938* [1]

Physiographic area	All farmers	Farm operators				Nonmanaging tenants and croppers
		Owners	Share tenants	Cash tenants	Total operators	
	Number	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Pontotoc Ridge	2,961	40.6	3.4	0.7	44.7	55.3
Flatwoods	2,587	36.8	4.9	.8	42.5	57.5
Clay Hills [2]	3,116	39.1	5.0	2.5	46.6	53.4
Brown Loam [2]	1,853	40.3	4.0	9.7	54.0	46.0
Watershed	10,507	39.1	4.4	3.1	46.6	53.4

[1] From Agricultural Adjustment Administration records, 1938.
[2] Does not include Sardis Reservoir purchase area.

Tenant farmers or sharecroppers cannot be expected to employ conservation measures requiring an outlay of cash when their tenure on the land is usually only a year or two. Generally speaking, tenants "cash crop" a higher proportion of the farm and have less pasture than owner-operators. Furthermore, according to Agricultural Adjustment Administration data, tenants have worked out only three-fourths as much of the soil building [12] conservation payments as have owners. These factors suggest that the present system of short tenure has been a factor in aggravating the erosion and surface run-off conditions in the watershed.

Almost half of the farms in the watershed, on the average, are mortgaged for approximately 36 percent of their value (table 6). In addition, farmers are borrowing an average of $143 each year on a short-term credit basis at an average rate of 6.5 percent interest

[12] Payments for soil building practices are listed in appendix, exhibit E.

(table 7). This condition of indebtedness, although not radically different from that in more prosperous farming areas, is especially significant in view of the relatively small farm income in the Little Tallahatchie watershed. The current average loan of $143 represents 29 percent of the average net farm income. Actually, most farmers in the watershed must borrow money in the spring to finance the season's farm operation. This indebtedness forces the planting of as much cotton as possible to liquidate the loan. Except in unusual years, the fall harvest merely enables the payment of the loan—leaving barely enough money to meet the farmer's living expenses until spring. This continuing cycle of indebtedness demands a high proportion of cash-crop farming and discourages expenditures for conservation practices.

TABLE 6.—*Percentage of farms mortgaged and ratio of mortgage indebtedness to farm value, 1938* [1]

Physiographic area	Owner-operated farms mortgaged	Ratio of mortgage indebtedness to value of farms mortgaged
	Percent	*Percent*
Pontotoc Ridge	43.3	50.3
Flatwoods	54.5	38.5
Clay Hills	47.1	22.2
Brown Loam	48.0	46.4
Average, all areas	47.7	35.7

[1] From farm-management schedules on sample basis.

TABLE 7.—*Short-term credit conditions, 1938* [1]

Physiographic area	Average amount borrowed	Average term of loan	Average interest rate	Source of credit		
				Local banks	Individuals	Government agencies
	Dollars	*Months*	*Percent*	*Percent*	*Percent*	*Percent*
Pontotoc Ridge	156	8.8	6.6	33	50	17
Flatwoods	107	7.2	6.0	20	40	40
Clay Hills	138	6.5	7.2	40	40	20
Brown Loam	197	8.2	5.9	33	34	33
Average, all areas	143	7.4	6.5	30	45	25

[1] From farm-management schedules on sample basis.

Taxes require a cash outlay that the farmer finds hard to make with his small cash income. As compared to other Southern States the average per acre tax rate in the watershed and the percentage of tax-reverted land seem to be small (table 8); however, farm incomes are also comparatively low, largely because little income is derived from idle abandoned land or the cut-over forested land. Thus, the tax load of the watershed is a heavy burden on the farmer, and represents another incentive to perpetuating an agricultural system which returns the greatest possible immediate cash return. In addition to regular property taxes, a large percentage of the bottom land has been subjected to heavy drainage taxes in the past.

TABLE 8.—*Assessed valuation, tax burden, and tax-reverted land, 1938* [1]

Physiographic area	Per-acre assessment		Total tax		Tax-reverted land	
	Cultivated land	All farm land	Per acre of farm land	Per dollar of assessed value	Area	Distribution
			Cents	*Mills*	*Acres*	*Percent*
Pontotoc Ridge	$16.75	$7.85	26	33	1,596	9.7
Flatwoods	16.13	7.42	25	34	1,323	8.1
Clay Hills	13.98	6.36	18	28	7,052	42.9
Brown Loam	13.11	5.21	15	29	6,458	39.3
All areas	14.64	6.37	19	30	16,429	100.0

[1] From County records.

The creation of the Sardis Reservoir as part of the United States Engineer Department flood control plan for the Yazoo Basin has created two problems: (1) The extreme northwestern part of Lafayette County has been isolated from the county seat at Oxford. Future county administration of this area will be difficult and various hardships will thereby be imposed on the inhabitants because of the isolation from the rest of the county. The Lafayette County Land Use Planning Committee has advocated abandonment of this area for agricultural use because they believe the land suited for agriculture is insufficient to justify county services in the area. In this instance, however, county reorganization might be a solution to continued use of part of this area for agriculture. (2) The purchase of land for the Sardis Reservoir obligated retirement of approximately 11,000 acres of the best bottom land in the Little Tallahatchie watershed and removal of about 550 families. Many of these families moved to the hills and began cultivation of steep slopes; others moved entirely out of the watershed. Compensating for the loss of good land in the watershed above Sardis Dam, a large amount of good bottom land on the Tallahatchie River below Sardis Dam became immediately available for crop use. Unfortunately, however, land companies purchased much of the land to be protected from floods long before the Sardis Dam was completed and the price put on the land became prohibitive for the displaced population.

FLOOD CAUSES AND CHARACTERISTICS

A flood is any stream rise exceeding the capacity of the channel. Although the primary cause of any stream rise is precipitation, the magnitude of the rise depends not only on the volume, rate, and distribution of the precipitation but also on the volume and rate of surface run-off (which in turn are influenced by the infiltration capacity of the soil) and on the characteristics of the stream system as well. Within the Little Tallahatchie watershed these factors combine to establish very severe conditions of frequent flooding; on some of the tributaries, damaging over-bank flows occur on an average of 15 occasions annually.

Flood-producing storms.

Within the Little Tallahatchie watershed, storms which produce floods can be classified as: (*a*) Tropical hurricanes, (*b*) frontal storms, and (*c*) thunderstorms.

Hurricanes originate in the Tropics and are always potential flood producers. They form over the Caribbean Sea or Gulf of Mexico and move inland, occasionally passing over or near the watershed, causing rains which last from a few hours to several days. They are most likely to occur between June and November and one storm may produce as much as 20 inches of precipitation, some of which falls at high intensities.

The frontal-type storm frequently produces heavy precipitation when a moist, warm air mass flowing northward from the Gulf meets a stationary cold air mass. Under these conditions the humid, warm air is elevated and causes almost continuous light to moderate precipitation, increasing at times to an intense rain. These storms usually last longer than other types and have produced some of the greatest floods on record.

Thunderstorms are very common in the watershed. They may occur in any month of the year but are most frequent during the warmer months. Though the rainfall is usually intense, it seldom covers a large area. Ordinarily, thunderstorms do not produce flooding on the entire watershed, but frequently cause local floods along the tributaries.

Hurricanes and thunderstorms are the most important types, because usually they occur during the growing season and give rise to floods that cause serious damage to crops. The frontal-type storms usually occur during the winter and early spring months, frequently producing floods which delay planting. Occasionally they occur late enough in the spring to ruin early plantings.

Surface run-off and infiltration.

Surface run-off is a flood characteristic that can be modified to reduce flooding. The volume as well as the rate of surface run-off for a given storm is largely controlled by the infiltration-capacity of the soil, which in turn is importantly influenced by the soil texture and structure and the vegetal cover. There is ample storage capacity in the deep, rock-free soils of the Little Tallahatchie watershed to store almost unlimited quantities of additional infiltrated water; any increases in the infiltration-capacity, or rate at which water percolates into the soil, will therefore result in a lessened rate and volume of surface run-off.

Survey investigations show that most classes of land, under the prevailing system of land use, have low infiltration-capacities and contribute excessive rates and volumes of surface run-off. This applies especially to the cultivated and severely eroded areas that are in a more or less barren condition but also pertains to extensive areas of grassland, woodland, and partially restocked open land on which plant cover has deteriorated. Investigations show conclusively that the infiltration-capacity of such areas can be greatly increased by restoring or improving watershed cover and by applying various water-retardation and soil-conserving measures to the agricultural lands (appendix S).

Characteristics of the stream system.

The characteristics of the stream system influence the distribution of a given volume of stream run-off and thus modify either favorably or unfavorably the crest stage of a flood. The most important

characteristics are: (*a*) The drainage pattern, (*b*) the stream gradient, (*c*) channel capacity, and (*d*) flood-plain topography. Within the Little Tallahatchie some of the factors that increase flooding and the resulting damage can be modified to alleviate flooding.

The two principal tributaries of the Little Tallahatchie have numerous small tributaries throughout their length. Ordinarily, this pattern would result in high peak discharges for a given flood volume, but both of the principal tributaries now drain into the Sardis Reservoir, thus eliminating increased floods caused by synchronization of flow.

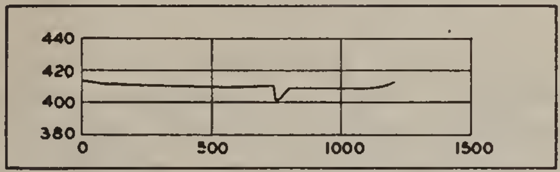
The gradients of the Little Tallahatchie streams are relatively flat. They increase from approximately 2 feet per mile at the mouth of the principal tributaries to about 30 feet per mile in the headwaters. The flat gradients cause low velocities of water, resulting in deposition of sediment and subsequent increased flooding.

One of the most important causes of the excessive flooding is the choked (or plugged) condition of the stream channels. With the exception of the ditched streams in the Flatwoods, channels are usually inadequate to carry the present run-off—a condition caused primarily by the large volume of sand deposited in the channels. In many ditched streams in the Brown Loam the deposition has progressed so far that the channel bottoms are actually above the level of the flood plain. Typical examples, illustrating the inadequate capacity of channels, are shown in figure 5, the examples representing points on the streams with drainage areas ranging from 11.6 to 492 square miles.

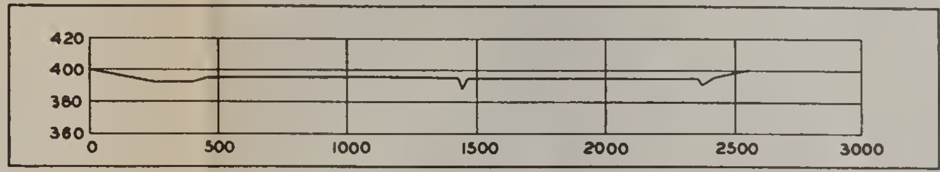
The shape and size of the flood plain has a pronounced effect on the duration and depth of flooding. Wide flood plains usually contain more damageable property than narrow ones and suffer more loss and destruction for a given flood volume. The flood plains of the Little Tallahatchie system are exceptionally broad, considered in relation to the drainage area. Flood plains along the entire length of the streams from the mouths of the principal tributaries to the headwaters are damaged annually by flood water. Widths of flood plains are illustrated in figure 5, which shows two examples covering the range in widths for small drainage basins of approximately 12 square miles, and two for the major tributaries near their mouths. In general, the greatest width of flood plain exists in the Flatwoods and the smallest in the Pontotoc Ridge. Even the areas inundated by minor floods are large. Along one of the tributaries at a point above which the drainage area is only 11.6 square miles, the average annual flood inundates nearly 750 acres. This and other examples showing the extent of areas inundated are shown in table 9.

TABLE 9.—*Flood-plain areas inundated by the average annual flood*

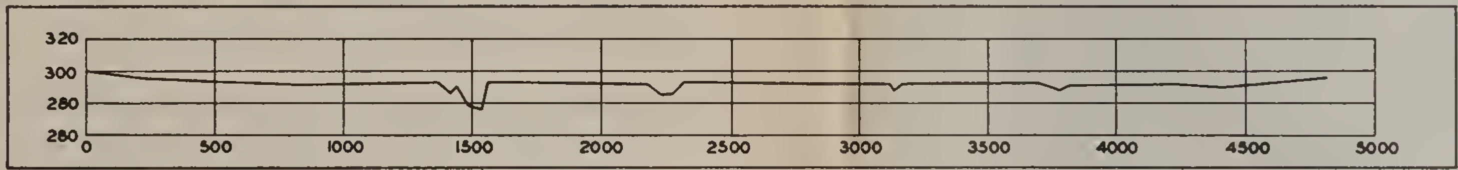
Sample streams	Physiographic area	Drainage area	Area inundated
		Square miles	*Acres*
Hell Creek	Flatwoods	11.6	740
Upper Tallahatchie River (headwater area)	Pontotoc Ridge	12.8	270
Tippah Creek	All 4 areas	363.0	15,500
Tallahatchie above Etta gage	do	628.0	37,200



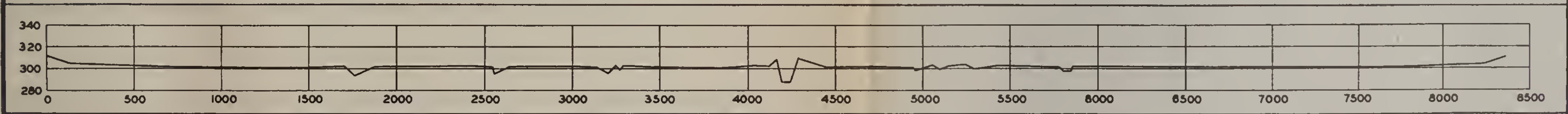
UPPER TALLAHATCHIE RIVER
CROSS SECTION NO. 5
DRAINAGE AREA = 12.8 SQUARE MILES



HELL CREEK
CROSS SECTION NO. 6
DRAINAGE AREA = 11.6 SQUARE MILES



MAIN STREAM - TIPPAH CREEK
CROSS SECTION NO. 23
DRAINAGE AREA = 350 SQUARE MILES



MAIN STREAM - TALLAHATCHIE RIVER
CROSS SECTION NO. 20
DRAINAGE AREA = 492 SQUARE MILES

NOTE:
ALL ELEVATIONS ARE IN FEET ABOVE MEAN GULF DATUM
DISTANCES ARE IN FEET

TYPICAL VALLEY CROSS SECTIONS ON TRIBUTARIES AND MAIN STREAMS

LITTLE TALLAHATCHIE WATERSHED–MISSISSIPPI

U. S. DEPARTMENT OF AGRICULTURE
FLOOD CONTROL SURVEYS
JULY 1941

79701—43 (Face p. 16)

FIGURE 5.

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Flood characteristics.

The foregoing causes of flooding have combined to produce a maximum of 155 floods on one of the minor tributaries during the 10-year period from 1929 to 1938. Of this number 38, or approximately 4 per year, occurred during the growing season. Few streams of comparable size have a greater frequency of flooding. The total area flooded by the average annual flood is 99,000 acres. This constitutes over 11 percent of the entire watershed exclusive of the Sardis Reservoir purchase area and about 54 percent of the total bottom-land area.

Some pertinent facts illustrating flood characteristics within the three tributary areas are as follows: (*a*) Little Tallahatchie tributary area. The average annual flood inundates approximately 56,000 acres. About one-half of this acreage is inundated as often as 10 times a year. Run-off volumes are the highest of the three areas. (*b*) Tippan tributary area. The average annual flood inundates approximately 28,000 acres. About one-fourth of this acreage is inundated as often as 10 times annually. Run-off volumes are the second highest of the three areas. (*c*) Reservoir tributary area. The average annual flood inundates about 15,000 acres of the minor tributary bottom lands. About one-third of this acreage is inundated as often as 10 times annually. Run-off volumes are the lowest of the three areas.

In the Little Tallahatchie and Tippah tributary areas, one-third of the area inundated is main-stem bottom and two-thirds minor tributary bottom land. In general, floods in all areas rise rapidly from very low flows to the crest and fall less rapidly to approximately the normal flow. The duration of out-of-bank flow varies with the channel and flood-plain characteristics as well as with the storm pattern, but the average duration is about 1 day. In the past highway bridges of inadequate capacity caused channel constrictions that aggravated flooding; many of these have been damaged and subsequently replaced with new bridges with a much greater discharge capacity.

Chapter II. Flood, Sediment and Erosion Damage

Practically every acre in the watershed suffers some form of damage caused by storm run-off or floodwater, under present conditions of land management. In the uplands it is erosion or colluvial deposits of harmful sediment; in the bottoms it is severe floodwater and sediment damage resulting from approximately 15 floods annually. Floods occurred more than a century ago even when the area was predominantly in forests, but the severity and frequency of floods and concomitant damage have been multiplied by extensive clearing and misuse of the upland. Infiltration studies reveal that run-off from pine forests in their present condition, is seven times as great as that from similar pine stands which have had protection from fire, grazing, and overcutting. Thus, even if the entire watershed were still in forests, but these were abused as at present, the total run-off would be many times greater than that from the original, well-protected watershed, as De Soto saw it in 1541.

Accelerated erosion from misuse of uplands has increased enormously the rate of sediment contribution to bottom lands and stream channels. The resulting abnormalities of channels and flood-plain

topography are reflected in the steadily decreasing productivity and gradual abandonment of the fertile bottom lands—areas which should be the mainstay of a permanent agriculture.

FLOODWATER DAMAGE [13]

Damages from floodwater are recurrent, not only annually, but usually many times each year on the same area. Without an upstream flood-control program floodwater damages similar to those suffered during recent years will be experienced in the future; in all probability they will become more critical as upland misuse is extended. In order to gage the magnitude of this problem, floodwater damage was studied for the 10-year period, 1929 through 1938, which was found to be about average. The results indicate a total annual floodwater damage of $342,973,[14] of which $301,483 was agricultural loss. The remaining $41,490 was damage to roads and railroads.

Approximately 97 percent of the total annual agricultural loss is actual damage to crops, including both the shrinkage in yield and the additional cash expense for replanting. The remaining 3 percent of agricultural impairment represents loss of livestock, stored crops, farm improvements, and miscellaneous damages.

Approximately 48 percent of all cleared flood plain is planted to corn and 22 percent to cotton; the harm to these two crops represents 94 percent of all agricultural floodwater damage (pl. 3).

A good indication of the variability and severity of floodwater losses can be obtained from a comparison by physiographic areas of the annual crop damage per cultivated acre of flood plain, since this land generally furnishes the bulk of the farm income. This damage is most severe in the Clay Hills, amounting annually to $5.35 per acre; it averages $4.28 in the Pontotoc Ridge, $2.63 in the Brown Loam, $2.62 in the Flatwoods, and $4.20 for the entire watershed.

State and county highway officials and railroad officials estimate the average annual damages in this watershed to be: Roads, $39,591; railroads, $1,899. Part of this is increased maintenance because of floodwater damage, and part of it is the periodic cost of re-elevation of fills and bridges because of gradual accumulation of sediment in channels and on flood plains (pl. 4).

In summary, floodwater damages in the Little Tallahatchie watershed are $342,973 annually, of which 85 percent or $292,180 is crop damage, 3 percent or $9,303 is other agricultural damage, and 12 percent or $41,490 is damage to roads and railroads. The Tallahatchie tributary area accounts for $225,061, the Tippah tributary area $81,147, and the Reservoir tributary area $36,765.

SEDIMENTATION DAMAGE [15]

Damage from sediment is not usually spectacular, as is that from floodwater, but its cumulative effects gradually assume serious proportions. In the aggregate it has caused more harm in the Little Tallahatchie watershed in the past hundred years than has been caused by recurrent floodwaters.

Accelerated erosion of upland soil has caused deposition of erosional debris on bottom land in ways both beneficial and harmful at the

[13] Refer to appendix, exhibit F, for tabulation and detailed description of floodwater damages.
[14] This does not include the annual floodwater damage that is attributable to sedimentation processes.
[15] Refer to appendix, exhibit G, for detailed description of sedimentation damages.

same time on different acres. The net harmful effect of sedimentation by types and degrees has been mapped and calculated, and the present and future rates of increase determined.

Three major classes of sediment damage are recognized. Deposition (pl. 5), swamping (pl. 6), and increased flooding caused by sedimentation (pl. 7). The first two are distinct sedimentation damages and can be calculated separately, but the last is interrelated with floodwater damage and must be computed in combination with that damage.

Computed on the basis of the potential productiveness of the flood plains, the present loss in productivity was determined, together with the rate at which each of the three types of sediment damage is

PLATE 3. Flooded bottom lands on Hell Creek, May 22, 1939. This field was planted to cotton and apparently had a perfect stand before the flood. Water had receded 2 feet when the picture was taken.

increasing. Through use of these rates, damage can be estimated for any period in the future, and the annual decrease in net productivity can be calculated. This represents damage that a soil-conserving program on the uplands will greatly alleviate.

The present annual agricultural damage [16] from sediment (decreased net productivity and increased flooding caused by sedimentation) is approximately $591,023. This is the result of past sedimentation. Some lands can be reclaimed by natural processes and again used for agriculture if the rate of sedimentation is reduced. Of the total damage caused by sedimentation, increased flooding is responsible for approximately 31 percent, while deposition and swamping account for the remaining 69 percent.

[16] This should not be confused with average annual damage, since it does not represent past or anticipated future annual damage. Present annual damage was computed by determining the net decreased productivity on all flood-plain acres caused by sedimentation during the period of agricultural development and the increased floodwater damage attributable to sedimentation, expressing this in terms of reduced annual income per acre. The aggregate annual loss for the present year represents present annual damage.

PLATE 4. Stream bed under highway bridge completely blocked with sand. Brown loam physiographic area.

PLATE 5. Looking away from channel bank across cotton field covered by sand splayed out of plugged section of Tobitubby Creek, 2 miles west of Oxford, Miss.

PLATE 6. Channels plugged with sand and debris cause swamping on adjacent flood plains.

PLATE 7. Small stream in flood stage, Brown loam physiographic area. The inadequacy of the sand-choked channel causes flooding during almost every storm.

The Brown Loam and Clay Hills have each suffered approximately 40 percent of the sedimentation damage, the Pontotoc Ridge follows with 12 percent, and the Flatwoods lowest with only 8 percent. By tributary areas, the damage is $220,029 for Tallahatchie, $138,557 for Tippah, and $232,437 for the reservoir tributaries. In accordance with the rates of sedimentation to be expected in the future without a remedial program, the annual loss will increase each year by about $2,284 in the Tallahatchie tributary area, $1,231 in the Tippah tributary area, and $1,043 in the reservoir tributary area. Without a program, in 20 years the annual agricultural damage from sediment will rise to approximately $682,174 for the watershed, a total increase of $91,151.

Woodland makes up 33 percent of the flood plain in the Brown Loam, 27 percent in the Clay Hills, 21 percent in the Flatwoods, and only 4 percent in the Pontotoc Ridge. Most of this woodland has been severely cut over and is now predominantly stocked with noncommercial species. The greater portion of forested land in the bottoms is not the result of preference on the part of owners, but of forced abandonment or frustrated agricultural efforts because of abnormal floodwaters and flood-borne sediment. Some stands of timber have been killed by submergence caused by changes in a stream course, or by abnormal deposition of sediment on natural levees, thus forming ponds or swamps on contiguous flood-plain areas. The aggregate damage to timber from floodwater is believed to be relatively small.

Although the Sardis Reservoir covers 10 percent of the total area of the watershed and was designed with a high safety factor to care for sedimentation, studies indicate that 18 percent of its capacity will be lost in 100 years because of sedimentation. Of the 18-percent loss, between 2–3 percent will be in the permanent pool, hence the reduction in flood storage capacity will be slightly more than 15 percent. The United States Engineer Department has estimated [17] that a loss of 15 percent of the total storage capacity (13 percent of flood storage) will probably necessitate additional structures or alterations in design that will cost approximately 4½ million dollars. At the expected rate of sedimentation, these changes will be required in approximately 83 years. The annual cost of establishing a sinking fund of 4½ million dollars in 83 years is $9,609 and represents the expected annual damage to the reservoir chargeable to sedimentation.

To summarize, the present total annual damage from sediment is $607,655, of which $409,569 is caused by deposition and swamping, $181,454 [18] by increased flooding due to sedimentation, and $9,609 by sediment damage to the Sardis Reservoir. It should be noted that cumulative sedimentation damage (unlike floodwater damage reduces the productivity of the land or, in the case of increased flooding due to sedimentation, permits lesser flood volumes to cover more flood plain, so that as sedimentation increases, crop yields become lower and lower. This net loss in production represents a direct flood damage that can be reduced appreciably by an upstream flood-control program.

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[17] Source: Conferences, Vicksburg office.

[18] This is over and above the $342,973 of strictly floodwater damage. The two are computed together in benefit evaluations (ch. VI).

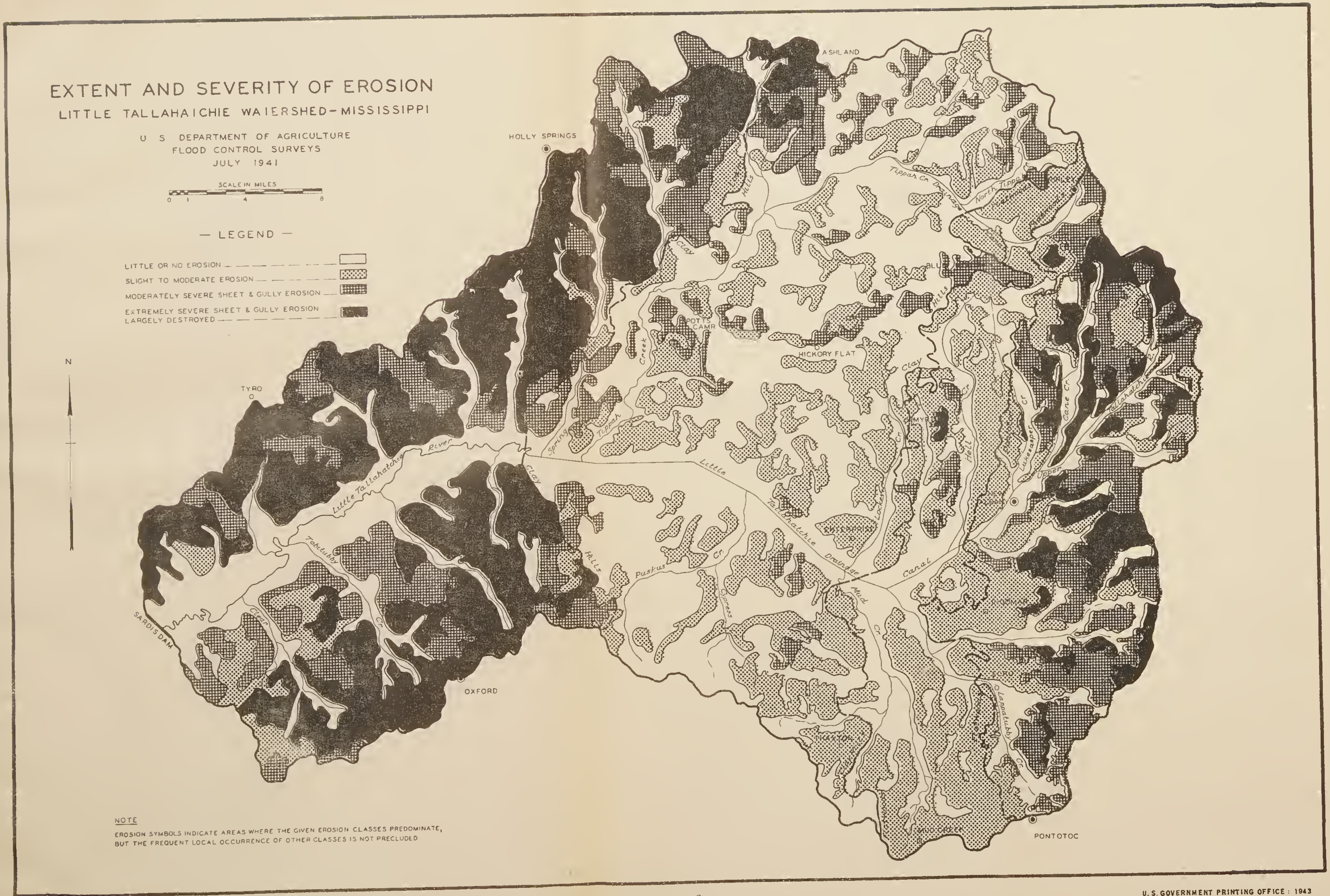

FIGURE 6.

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INDIRECT FLOOD DAMAGE

Damage from floodwaters and sediment is not confined to the measurable monetary loss resulting from reduced crop yields, fields covered with sterile sand, roads and bridges washed out, or reservoirs and lakes impaired by deposits of sand and debris. Indirect losses may even exceed the direct damage heretofore described.

When severe floods occur, the cotton and corn crops yield but a small percent of what was expected. To the farmer this means lessened cash income and a lower standard of living, less feed for livestock and consequent overgrazing of pasture land, and liquidation of timber resources. To the cotton gins and merchants of affected communities, it means a lowered volume of business perhaps necessitating increased prices to further burden the farmer. Highway damage requires heavier expenditures by county governments, necessitating increased taxes. Road damage also causes delayed or increased travel, adding to the expense of local and other traffic. Continued flooding and sedimentation in the Sardis Reservoir foreshadow deterioration of recreational values that now attract thousands of hunters, fishermen, and pleasure seekers each year.

Although these indirect damages can be neither wholly nor accurately evaluated, they are conservatively estimated to aggregate at least 25 percent of the direct damage or approximately $238,000.

Two lives are known to have been lost in floods in the watershed, but in general the hazard is small because practically no homes are located within the flood plains.

EROSION DAMAGE [19]

Erosion in the Little Tallahatchie watershed is probably as severe and widespread as anywhere in the eastern United States (fig 6). Severe or very severe sheet and gully erosion occur on approximately 45 percent of the Pontotoc Ridge, 50 percent of the Brown Loam, 23 percent of the Clay Hills, and 8 percent of the Flatwoods. This condition has resulted from the evils of improper use of land that is highly susceptible to erosion. Over a period of a century, farmers have practiced "cotton farming," which necessitated the planting of cotton on the land year after year. As little or no effort has been devoted to establishing soil-conserving practices, at least 294,000 [20] acres have been forced out of cultivation because of advanced erosion. Of the present open and abandoned land approximately 75,000 acres are totally ruined for crop use and should be restored to some type of permanent vegetal cover (pl. 8).

Sheet erosion has been a large factor in erosion damage throughout the watershed. Being less spectacular, it usually passes unnoticed until gall spots and subsoil begin to appear in cultivated fields and yields begin to decrease rapidly (pl. 9). Survey determinations indicate that a total of approximately 226,120,000 tons of soil, an average of 891 tons per upland acre, have been removed from the Brown Loam area by sheet erosion alone. Approximately 125,326,000 tons, 772 tons per upland acre, have been removed from the Pontotoc

[19] For detailed information on erosion, see appendix, exhibit H

[20] See land classification data, appendix, exhibit J. Includes all open abandoned upland and all abandoned upland reverted to forest as determined by studies of forest land for infiltration complexes.

Plate 8.—Abandoned upland area in the Brown Loam; it is severely gullied and completely destroyed for further agricultural use.

Plate 9.—After 3 years of cultivation sheet erosion has caused abandonment of this field. Severe shoestring gullies are now prevalent and will complete the job of destruction. Brown Loam physiographic area.

Ridge; 790 tons per upland acre from the Flatwoods and 597 tons per upland acre from the Clay Hills (appendix, G).

Gully erosion is the most ruinous to the uplands where it occurs and to lowland areas where the eroded material is deposited. Whereas sheet erosion causes movement of fertile topsoil that is often beneficial where it is deposited, gully streams normally transport sterile sand and clay that will permanently damage the land they cover. Serious erosion occurs on approximately 32 percent of the land in the Brown Loam, 22 percent in the Pontotoc Ridge, 7 percent in the Clay Hills, and 4 percent in the Flatwoods. An average of approximately 3,620 tons of soil per acre has been removed by gully erosion alone from 40,265 acres of abandoned land of the most severely eroded class in the Brown Loam. In the Pontotoc Ridge an average of 1,092 tons per acre has been removed from 13,323 acres of the most severely gullied land. Overwhelming as these figures appear, they are really conservative, since this much and more erosional debris can be accounted for through valley-fill studies carried on in the watershed. The difference in the volume removed from gullies in the two areas cited, is reflected by the difference in the type of gullying. The Brown Loam gullies are of the deep, straight-walled, caving type, often attaining a depth of 50 or 60 feet and encompassing several acres of land, whereas those in the Pontotoc Ridge are relatively shallow, with firm, sloping banks, so that a corrugated appearance results when they occur in close association. Gullies in the Brown Loam are much more difficult to stabilize because of the rapidity with which they develop.

In many areas throughout the watershed, destruction by gully erosion has been so complete that stabilization is beyond the means of the private owner. Years will be required to do the job even with the most stringent measures and it is very doubtful if the land can ever be successfully reclaimed for intensive agricultural use. It is also doubtful if profits from timber can be realized from such land until after the first or second generation of trees. The rational treatment of this land, therefore, should be one which is aimed at restoring plant cover and managing the area primarily for watershed protection in the interest of flood control.

SUMMARY OF DAMAGES

Average annual floodwater damage in the watershed during recent years has amounted to $342,973. In addition, an annual loss of $591,023 can be attributed to increased flooding caused by sedimentation and a reduction in net productivity of flood-plain land as a result of sediment; furthermore, the annual rate of sedimentation is increasing progressively. Annual sediment damage to the Sardis Reservoir is computed at $9,609. Indirect damage, although not susceptible to actual evaluation, is estimated to be at least 25 percent of the direct damages or $238,000. Erosion damage, although not evaluable, has also caused a staggering loss, and is progressively increasing the same as with sediment damage. Thus total estimated damage at the present time is $1,181,605 per year and will increase as additional productive land is damaged by sediment.

Chapter III. The Flood Problem

If a policy of conservation rather than exploitation had been put into practice in the Little Tallahatchie watershed during the past soils, abundant rainfall, and an equable climate would by now have resulted in a highly developed, permanent, and prosperous agriculture. As it is, most of the watershed has been transformed into a problem area wherein the widespread abuse of uplands contributes materially to flood and sediment damage on all flood plains and threatens the security of what might otherwise have been a stable and flourishing economy. Circumstances common to southern agriculture have necessitated the use of a type of tillage which leaves extensive areas unprotected from the elements and hence susceptible to erosion. Improper use of land early brought on abnormal conditions of flooding and the result of continued maltreatment during the past century has increased severalfold the surface run-off from nearly all classes of land. This multiplied surface run-off converging in sediment-choked stream channels has induced conditions that make it possible for less than one-half inch of rainfall to cause damaging floods. Thus, about 120,000 acres, or 65 percent of the total bottom-land area, are now subject to floods; 99,000 acres or 54 percent of all bottom lands are flooded once each year, and about 39,000 acres are flooded 10 times or more every year. Each year an average of approximately 4 floods occur during the crop season. The average annual floodwater damage is about $343,000, while the present annual loss caused by sedimentation is now approximately $591,000, thus the total direct annual damage at the present time is almost a million dollars.

During the past three decades, the economy of the basin has been increasingly dependent upon the bottom lands. The livelihood of 66 percent of the rural population now largely depends upon the income from bottom lands, since much of the upland soil is spent and abandoned. Erosion has forced out of cultivation about 294,000 acres, or one-third of the watershed area, of which only 100,000 acres has reverted to an indifferent forest cover. Approximately 75,000 acres of the present open abandoned land is virtually ruined for agricultural use (pl. 10) and is in a barren, actively eroding condition.

In direct opposition to the greater demands on bottom land are the overwhelming circumstances of increased flood, and sedimentation which not only destroy crops but also in the latter instance progressively reduces the productive capacity of the land. Potentially the bottom lands should be capable of returning $1,570,000 net income annually; their present annual net production is only $979,000. Another circumstance which makes for greater scarcity of productive land is the completion, recently, of the Sardis Reservoir, embracing 53,250 acres of bottom land, of which 22,814 acres were cultivated. Approximately 11,300 acres can never be cultivated again; the remaining 11,514 acres can be cultivated, but at the risk of flooding.

More than one-half the farmers of the watershed are nonmanaging tenants. Almost one-half of all farms are mortgaged on an average of 36 percent of their value. Farmers are borrowing an average of $143 per year on a short-time credit basis at an interest rate of 6½ percent; it is a striking fact that such a loan represents about 29 percent of the average net farm income. The present system of farming tends to perpetuate a cycle of indebtedness in that the farmer usually realizes insufficient return from a given harvest to repay the previous year's debt and at the same time finance the new crop. The tax rate does not appear excessive, but owing to the high percentage of abandoned land and the low productivity of the soil, the tax load in the watershed is nevertheless a severe burden to its occupants.

Throughout the watershed the story is much the same and follows a familiar pattern: early development and exploitation of the upland without regard for soils, slope, or cover; later development of the flood plains because the uplands could no longer carry the financial load; losses from floods and attempts at drainage with flood ditches which generally filled and were rendered useless by sediments pouring from gullied uplands; and finally a futile attempt at both upland and bottom-landfarming in spite of land impoverishment and flood damage.

The result invariably has been a decline in yields with a consequent decline in incomes and rural economy. Many abandoned plantation homes, once luxurious, are rotting on their foundations and are commonly occupied by Negro tenants. Schools, churches, roads, and even villages show the effect of improper land use, and flood damage and erosion are completely undermining an area that was at one time known as a cultural center of the South.

In spite of past abuses there still remain fertile bottom land and productive upland that can be farmed continuously with proper care and treatment. Conservation practices can reduce the storm run-off and almost completely stop erosion from cropland; trees and other permanent vegetation, supplemented by simple mechanical measures, can quickly provide a vegetative mat over gullied, barren ground and will drastically reduce both storm run-off and soil movement. An upland program of this sort will reduce floods to the extent that farmers can safely till the bottom-land soils and have reasonable assurance of producing and harvesting a good crop. To accomplish such a program will require marked readjustment in cropping practices and in the treatment and management of forests and other wild lands; and, furthermore, will necessitate sustained efforts by landowners in maintaining the various measures at full effectiveness. The remedies which such a program will entail are not, however, as drastic as the damage caused by present conditions.

Chapter IV. The Remedial Program

The primary objective of a flood-control survey is to determine the nature and extent of flood and sediment damages and to determine and prescribe remedial measures that will alleviate flood conditions and assure reductions in flood losses. The flood-control program proposed herein will not only assist in reducing downstream flooding and sedimentation but will improve the economic condition of upland farmers.

PLATE 10.—Two views of the Woodson Ridge gully. This gully began 47 years ago when a ditch 2 feet deep and about 200 yards long was excavated in order to drain a small swamp on a low plateau area. The present gully is 60 feet deep, one-half mile long, and 13 acres in extent. In all, 981,028 tons of soil have been washed away, an average of 57 tons per day since the ditch was first dug, and enough sterile sand to cover 145 acres of fertile bottom land to an average depth of 3 feet. The gully receives drainage from an area of only 161 acres.

Several conservation agencies, none of which has flood control as its primary objective, are carrying out programs of land treatment similar in some respects to those needed for flood control.[21] Limited facilities and personnel preclude action on a scale large enough to have much immediate effect upon floods. This work must be speeded up and coordinated as proposed in this program. Otherwise, current destructive practices may very soon carry the problems of flood control beyond satisfactory solution.

The Forest Service has established fire control which covers approximately 225,000 acres of land in both Federal and private ownership. It has reforested more than 10,000 acres which comprise most of the open land on the 99,000 acres of national forest land in the watershed. The Soil Conservation Service has been instrumental in preparing soil-conserving plans on approximately 800 farms or 16 percent of the total number of farms in the watershed. The Agricultural Adjustment Administration has encouraged the practice of conservation to some degree on approximately 98 percent of the farms in the watershed. The Farm Security Administration is encouraging conservation work in the watershed through the media of farm loans, tenant-purchase loans, and other special services. The State agricultural extension service is doing its part along educational lines to assist in bringing about a completely coordinated and comprehensive program of conservation. A good beginning has been made, and coordinated efforts of all agencies and individuals should result in a sound, effective flood-control program.

For the purpose of study and to enable formulation of the remedial program as presented herein, a division was made of the watershed [22] into land classes, homogeneous as regards treatment needs and of such size as to permit detailed study and analysis. The first step in this classification was the delineation of the four major soil or physiographic areas, namely, Brown Loam, Clay Hills, Flatwoods, and Pontotoc Ridge. Each physiographic area was then divided into 20 use-condition classes based upon present land use, slope, and gully erosion. This was followed by detailed surveys selected within each physiographic area to obtain even more detailed information on soil types, sheet and gully erosion, slopes, and land use; this in order to gage the major land conversions and types of measures needed for flood control. An analysis of the data obtained through the preceding steps, supplemented by economic studies of farm income and management, revealed that rather extensive areas of land, because of favorable soil and topographic features and conditions of erosion, are predominantly suited to permanent agriculture. There are other areas that, because of adverse soil, topographic, erosion, or economic conditions, are predominantly not suited to agriculture and cannot be so used economically for any length of time, even with conservation practices; they should be retired to, or retained in, some form of permanent vegetal cover. The delineation of these two broad categories, referred to hereafter as agricultural and nonagricultural areas, was therefore a basic step in formulating a remedial program and largely determined both the type of measures required and organizational arrangements for carrying them out.

[21] For details of work done by each agency, refer to appendix, exhibit I.
[22] This procedure was termed area classification; for details of the methods involved, refer to appendix, exhibit J.

As a final step in formulating the program, samples of the various land classes in both the agricultural and nonagricultural areas were selected and studied in detail to determine the specific remedial measures required on each.[23] Wherever possible, those samples were concentrated on farm units on which detailed conservation surveys and economic studies had been made and, insofar as possible, farm land measures were adjusted to meet not only the requirments of flood control and the physical capabilities of the land but also the economic needs of the farmer.

The proposed remedial measures are not presented as a specific plan for operations work. Research and experience are responsible for constant changes and improvements, and up-to-date improved methods or measures will of course be adopted when the action program is inaugurated. The described measures in this report represent the best judgment at the present time and form the basis for the required evaluation of the remedial program.

Certain measures, such as the control of extremely large gullies by mechanical means, construction of upstream flood-control dams, extensive drainage work,[24] stream-bank erosion control, and development of a grazing economy in the nonagricultural area were considered and rejected as not feasible as part of this flood-control program.

After formulating the program, studies were made of the work accomplished in the watershed by the Forest Service and the Soil Conservation Service to determine the expected participation by the landowners. It was estimated that within a 20-year period after commencing the work, 80 percent of the watershed could be given the recommended treatment. In the following pages, all estimates of the extent and cost of the program, as well as the results and benefits, are based on the 80-percent participation.

The measures recommended in the remedial program fall into three major classes: (1) Those applicable to the entire watershed, (2) those applicable to agricultural land, and (3) those applicable to nonagricultural land. The measures applicable to the entire watershed are: Forest-fire protection and road-bank stabilization. The measures designed for a farm-land program on agricultural land consist of treating the cultivated land by rotating crops, terracing, and revegetating critical areas; developing pastures by constructing contour furrows, seeding and sodding, fertilizing, and fencing; treating farm woodlands by planting trees, constructing brush dams, and planting kudzu in gullies; and constructing diversion terraces where necessary. Treatment of the nonagricultural land is similar in type to the treatment of farm woodland but requires Federal land acquisition.

MEASURES APPLICABLE TO THE ENTIRE WATERSHED[25]

Fire protection.

Fire control is the most effective and feasible measure for the entire watershed from the standpoint of attaining flood reductions. Without fire control, the establishment of permanent vegetative measures would be uncertain and costly. Since fire alone can destroy the effectiveness of practically any other flood-control measure save those

[23] See appendix, exhibit K.

[24] Flood-control ditches were studied in detail by representatives of the Soil Conservation Service Division of Drainage. Refer to appendix, exhibit L, for the results of this study.

[25] The basis for costs of all phases of the program is presented in appendix, exhibit M.

relating to cultivated land, its control should be considered as an insurance measure to safeguard the public's investment and insure that the greatest benefits will accrue from the program. Lack of fire protection has already been responsible for some failures in earlier tree planting and gully-control work by conservation agencies and is mainly responsible for the lowered infiltration capacity of most forest soils.

The periodic burning of woods and fields is common practice on private holdings throughout the watershed and generally is caused by burning debris; setting fires ostensibly to improve woodland grazing; or carelessness in smoking, building campfires, etc. Elimination of these frequent fires will, more than any other measure, do much to rebuild forest resources and site qualities and to encourage the reproduction and growth of commercially valuable tree species.

The Holly Springs National Forest is the only extensive area in the watershed now being systematically protected from fire. Although the gross area of this national forest (within the watershed) is approximately 377,000 acres, present financial limitations permit the protection of only 225,000 acres, comprising land actually purchased plus 126,000 acres of contiguous, privately owned land which is located within natural firebreaks within the protective boundary. During the 3-year period 1937–39, a yearly average of 68 fires burned a total of 1,180 acres within this area. This is approximately one-half of 1 percent of the total protected area and illustrates the effectiveness of the fire-control program. In contrast, about one-third to one-half of the remaining private land in the watershed burns over at least once every 3 years.

Hilly topography and the large areas of present forest or areas to be reforested require a conventional type of fire-protection system, such as the Forest Service has successfully used in the area. In fact, the most satisfactory and least expensive arrangement will be to expand the Forest Service system to cover the entire watershed. This will require the installation of a fire-detection and communication system outside the present gross boundary of the national forest, and additional small equipment and transportation facilities for the entire area now unprotected.

A complete fire-protection system, including lookout towers, communication system, transportation facilities, and equipment, will be installed on the 577,125 [26] acres outside the present gross national forest boundary. This protection system will be designed to reduce the average annual burn to not more than 0.5 percent of the forested area of the watershed.

In addition to six fire towers now in use on the national forest within the watershed, eight 100-feet steel fire towers, eight cabins to house fire guards, and supplementary improvements will be needed and will cost approximately $39,000. These towers should be located approximately 12 miles apart (fig. 7). Communication lines are designed to connect all towers with a central dispatching office and all towers will be accessible by road. This will involve the construction of 146 miles of telephone lines and 2 miles of road at a total cost of $28,490. Also needed will be eight pick-up trucks and four 1½-ton stake-body trucks

[26] This acreage includes approximately 66,300 acres within the Sardis Reservoir that will be flooded only at infrequent intervals and is not now protected from fire. Approximately 20,401 acres of the national forest within the reservoir area is protected. Fire control is the only upstream flood-control measure recommended for the Sardis Reservoir purchase area to be financed from flood-control funds.

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costing a total of $9,250. Suppression equipment such as hand tools, back pumps, power pumps, etc., will cost approximately $4,060.

The total cost of installing this protection system amounts to about $80,800 for the gross area of 577,125 acres, or approximately 14 cents per acre. Coordinated with the present national forest system, it will be adequate for the watershed.

According to the experience of the United States Forest Service and the Mississippi Forest Service, the cost of operation and maintenance may run as high as 7 cents an acre per year for the first few years until public cooperation is obtained, and thereafter the annual cost will be 3½ to 4 cents per acre. Therefore, the cost of operating this protection system, including suppression of fires and replacement of the foregoing capital investments at the end of their useful life, is estimated at approximately 4 cents per year for each protected acre of forest land. Maintenance costs for fire protection will be required on 521,780 [27] acres and will amount to approximately $20,875 per year.

Federal funds will be used for the purchase and installation of the additional equipment needed and for the operation and maintenance of the fire-protection system on Federal land during and after the installation period.

Obtaining the operation and maintenance costs of 4 cents an acre annually from private landowners poses a serious problem. The present depleted condition of woodland and the fact that Federal land acquisition will cause changes in ownership of much of the land during the 20-year installation period make it impractical to secure private assessments during that period. It is believed that Federal funds should be used for this cost during the 20-year installation period. The State of Mississippi should be encouraged to participate in this public responsibility, but increased demands for fire protection in other parts of the State where forestry holds more promise precludes much hope of State participation in the near future.

After the 20-year installation period, forest stands will be better stocked and capable of returning some income to the forest owner. It is believed that private owners will then be in position to contribute half the cost of fire protection on their woodland. This can be handled by various means, and it does not seem propitious to suggest a solution for a problem that far distant.

Roadbank stabilization.

Raw backslopes and fill embankments on county and State roads throughout the watershed contribute much sediment to streams during intense storms. In the aggregate, sediment from roads makes up approximately 17 percent of that which causes damage in the stream bottoms. Considerable additional damage is caused where road-drains empty on cultivated fields and other property.

Approximately 1,400 miles of roads in the watershed have eroding cutbanks, fills, berms, and contiguous gullied areas that can be stabilized by vegetal treatments. Some of these are State highways and others are county roads, part of which are or will be maintained

[27] Installation costs are based on gross acres whereas operation and maintenance costs are based on forested acres. The installation equipment (fire towers, communications, etc.) must cover the entire watershed, whereas fire-suppression costs will be almost entirely confined to forest land. The State of Mississippi, in assessing private land for taxes to match Clarke-McNary Federal funds, assesses the noncultivable acres, as defined by the census, which correspond closely to the forest lands.

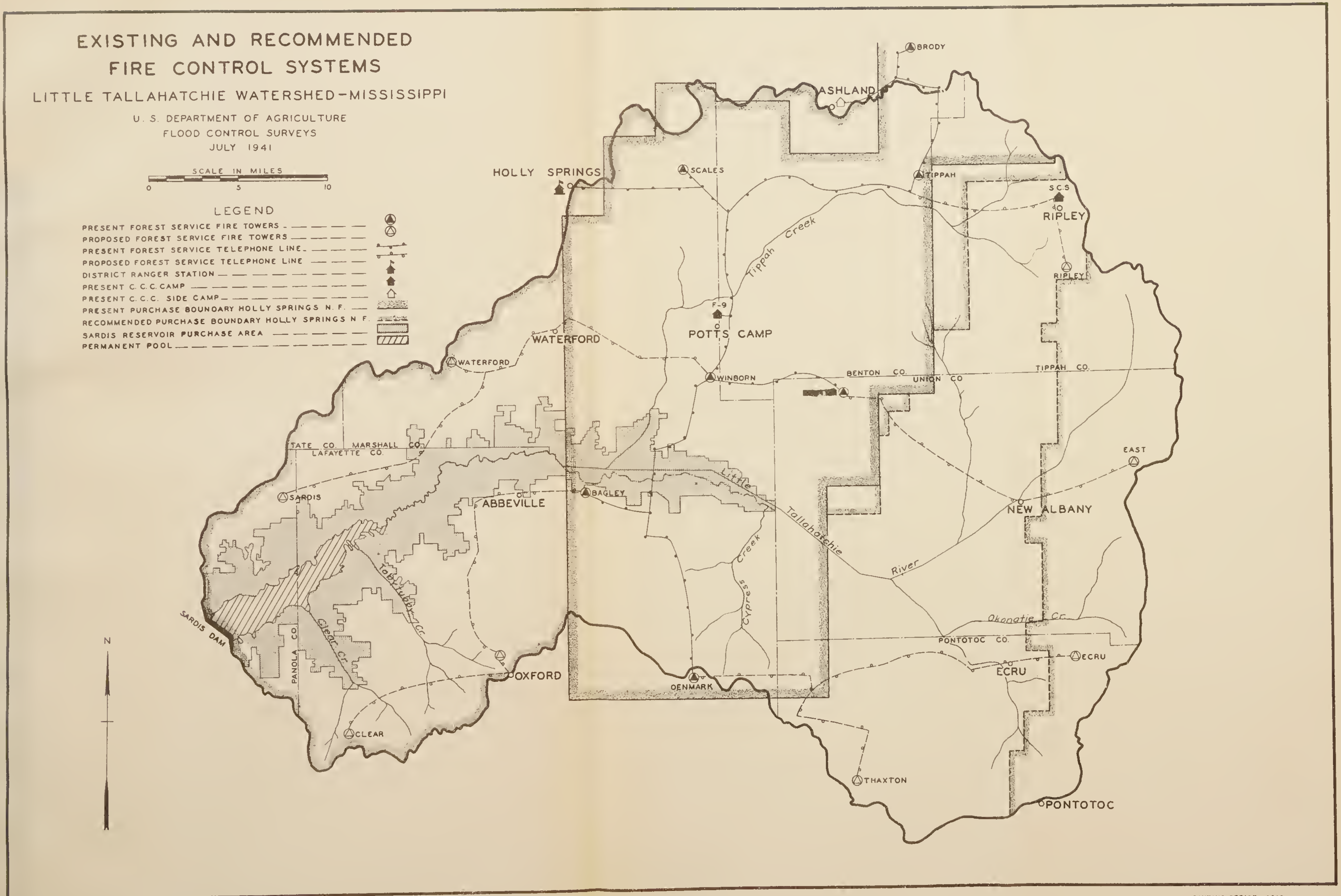

FIGURE 7.

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and specially utilized by the Forest Service. Treatment of local farm roads is included in farm-improvement plans and Federal highways are currently being treated through Federal-aid projects.

The treatment [28] involves sloping the roadbanks to a gradient of from 1:1 to 1½:1, depending on the vertical height and soil materials, applying a 3-inch layer of topsoil and approximately 2 pounds of fertilizer per 100 square feet, and spot sodding Bermuda grass or seeding Bermuda grass or Korean lespedeza. On the fills the treatment is more simple, involving either seeding Bermuda grass or mulching and "poling" with native materials, with a view to promoting the establishment of natural vegetation. The berms should be spot sodded with Bermuda grass and the gradients of roadside and lead-out ditches stabilized with simple check dams. Adjacent gullied areas should be treated with simple check dams and planted with loblolly or shortleaf pines or occasionally kudzu. The total cost of this treatment, including cost of sloping all cutbanks, which is normally a road-construction charge, is approximately $562 per mile of road.

Regular annual maintenance costs on this class of road before treatment amount to at least $100 per mile. Although no records have been found that give a comparison of regular maintenance costs before and after treatment, it is estimated [29] that effective treatment as described above will reduce annual road maintenance costs by at least half, or $50 per mile. Although this saving is ample to justify the work, additional flood-control benefits amounting to about 17 percent of those claimed for sedimentation reduction in this report are to be gained on bottom-land areas downstream which now sustain flood and sediment damages. Furthermore, the appearance of the roads will be greatly improved.

Roadbank stabilization work will be done on approximately 1,400 miles of road at a total cost of $786,800. On the 1,050 miles of State and local roads needing this treatment, Federal funds will bear 20 percent of the costs and on 350 miles of national forest roads, all of the costs will be Federal. This work will be accomplished during the first 5 years of the program.

Summary of measures applicable to the entire watershed.

Measures that apply to the entire watershed include installation of a fire protection system on 577,125 acres, maintenance of the fire protection system on 521,870 forested acres, and roadbank stabilization on 1,400 miles of State, county, and Forest Service roads (table 10). The installation of these measures, which will be accomplished during the first 5 years of the program, will require labor totaling 42,749 man-days annually, whereas maintenance and operation will utilize a total of 111,840 man-days during the first 20 years and 5,592 man-days annually thereafter (table 11).

[28] A complete study has been conducted on this type of treatment and is covered in a mimeographed report, A Project Plan for Roadbank Stabilization and Associated Erosion-Control Work on the Holly Springs National Forest, Miss., by H. G. Meginnis. Southern Forest Experiment Station, New Orleans, La., September 1940.

[29] This estimate was made by Roger S. Myers, city engineer of Oxford, Miss., who has gained knowledge of road-maintenance costs while employed by the Mississippi Highway Department. He states that annual maintenance costs on State gravel roads will run from $200 to $300 per mile per year and on county roads it will run approximately $100 per mile per year, at least half of which is maintenance of ditches, berms, banks, and fills.

TABLE 10.—*Quantitative requirements of measures applicable to entire watershed*

Tributary area	Fire protection	Road-bank stabilization	Tributary area	Fire protection	Road-bank stabilization
	Acres	*Miles*		*Acres*	*Miles*
Tallahatchie:			Reservoir:		
Total	303,370	691	Total	224,843	397
Annually	60,674	138	Annually	44,969	80
Tippah:			All areas:		
Total	48,912	312	Total	577,125	1,400
Annually	9,782	62	Annually	115,425	280

[1] Period of installation is 5 years for measures applicable to the entire watershed.

TABLE 11.—*Labor requirements for installation* [1] *and maintenance of measures applicable to the entire watershed*

Tributary area and measure	Installation		Maintenance	
	Annual	Total	Total for 20-year period	Annual after twentieth year
	Man-days	*Man-days*	*Man-days*	*Man-days*
Tallahatchie tributary area:				
Fire protection	867	4,335	40,700	2,035
Roadbank stabilization	20,286	101,430		
Subtotal	21,153	105,765	40,700	2,035
Tippah tributary area:				
Fire protection	140	700	24,640	1,232
Roadbank stabilization	9,159	45,795		
Subtotal	9,299	46,495	24,640	1,232
Reservoir tributary area:				
Fire protection	642	3,210	46,500	2,325
Roadbank stabilization	11,655	58,275		
Subtotal	12,297	61,485	46,500	2,325
Total	42,749	213,745	111,840	5,592

[1] Period of installation is 5 years for measures applicable to the entire watershed.

MEASURES ON AGRICULTURAL LAND [30]

Within the Little Tallahatchie watershed there are 503,663 [31] acres of land which the survey has delineated as best suited for permanent agriculture. It must not be overlooked, however, that this so-called agricultural land can be retained in agricultural use only if proper land use and conservation are most strictly practiced. The inherent characteristics of large areas of the watershed, particularly in the Brown Loam and Pontotoc Ridge, definitely limit the type of use and methods of tillage that may be employed. Vast areas of gullied, abandoned land and widespread economic distress furnish ample evidence that to proceed counter to these natural limitations leads only to disaster.

Crop rotation.

One of the greater evils of the present farming system in the watershed is the raising of cotton or corn on the same land year after year. This is caused by market conditions, a continuing need to produce a certain cash income each year, and the farmers' traditional reluctance

[30] See appendix, exhibit M, for detailed information on costs of remedial measures.
[31] Includes 33,353 acres of good agricultural land in the gross area designated as nonagricultural.

to adopt diversified farming, rather than by soil or climatic factors. For agriculture to attain any degree of permanence, the present cotton economy must give way to a more diversified system whereby the farm unit becomes more self-sustaining in both soil resources and economic returns. Diversification can best be attained through crop rotation accompanied by the introduction of new crops, capable of holding the soil and supplying the farmers' needs for food and cash crops. Close-growing crops in a system of diversified crop rotation protect the soil with vegetative cover throughout most of the year, in contrast to one-crop farming. Diversification through crop rotation also provides for a more intensive use of the land, better distribution of farm labor throughout the year, and greater yields in the future. It is the practice on many farms to plant winter legumes, such as burr clover, vetch, or winter peas, to follow a part (rarely more than one-fourth) of the clean-tilled crops, and to interplant a part of the corn with soybeans or cowpeas. This is a step in the right direction, since winter legumes alone may increase yields on the succeeding crop by as much as 35 to 50 percent, but it is far short of the desired goal because approximately three-fourths of the cultivated land is left bare and unused throughout a large part of the year. Substitution of oats, followed by annual lespedeza, for part of the corn would provide ample feed of greater variety for the farm livestock, as well as reduce surface run-off and erosion.

Although it is impossible to devise a rigid plan of rotation applicable to all cases, some type of crop rotation can be practiced on every farm. The following, which was used as a standard rotation in evaluating the remedial program presented in this report, is an example of many similar rotations that can be used on most of the agricultural land in the watershed:[32]

First year—Cotton followed by winter legumes.
Second year—Corn interplanted with summer legumes followed by oats planted in the fall.
Third year—Oats; annual lespedeza planted on oats in February. Lespedeza cut for hay in fall.
Fourth year—Lespedeza, reseeded from previous year.

This rotation provides for one-fourth of the cropland to be available for cotton each year. The remaining three-fourths is devoted either to feed and food crops or soil-improving and soil-protecting crops. Oats and lespedeza, both close-growing crops, are substituted for a large part of the corn previously grown. They serve the threefold purpose of providing protection against excessive run-off and soil erosion, increasing the productivity of the soil, and furnishing valuable food for farm livestock or for sale. The summer legumes interplanted with corn serve the same purpose.

Since farmers in the watershed already plant some of the essential crops mentioned in the suggested rotation, it is estimated that the additional cost to the farmer will be only approximately $2.36 per acre to establish the rotation and $1.25 per year thereafter for maintenance. The maintenance cost can be expected to decrease with the lessening of fertilizer requirements as the soil becomes more productive

[32] It should be understood that approximately one-fourth of the cropland is treated according to one part of the rotation each year; thus the rotation given is for a fourth of the cropland on the farm.

and as seed patches are established. Crop rotation is planned for 178,442 acres at an installation cost of $421,125 and an annual maintenance cost of $223,050 after the entire program is established.

What might be termed an adaptation of crop rotation is the practice of strip cropping whereby the close-growing crops of the rotation are arranged in contour strips on sloping land, alternating with strips of clean-tilled crops. These are usually rotated from year to year in compliance with the rotational scheme. Occasionally, a scarcity of suitable gently rolling land on the farm makes it desirable to retain steeper slopes in cultivation than is usually recommended. In such cases, alternate strips may be planted to some heavy-duty perennial, such as kudzu or perennial lespedeza, and rotated at intervals of several years or remain permanently in place. On the gentler slopes, strips of close-growing crops should be at least 30 feet wide and may be placed astride terraces or within terrace intervals, so spaced as to take up at least one-third of the area. On steeper slopes the width should be increased and the spacing reduced until, in extreme cases, 50 percent of the area is covered by close-growing crops. It is important that these strips be correlated with the terracing system, since their primary function in flood control is to assist or supplement the terraces in reducing surface run-off and soil erosion. Although strip cropping as an adaptation of crop rotation will assume an important place in the application of the remedial program on farm land, its use will not greatly affect the acreage distribution of the various crops outlined in the rotation above and no extra cost is involved.

Terracing.

The primary function of the terrace, a combination channel and earth ridge placed approximately on the contour of a slope, is the interception of surface run-off and regulation of its flow from the field, preventing concentration of water or velocities sufficient to induce severe erosion. Terraces alone are not enough to protect the land. Even though they spread the period of surface run-off over a longer time, they do not reduce greatly the total surface run-off. Thus, their major importance in flood control is in the protection given the soil against erosion, which in turn insures the effectiveness of the more important flood-control attributes of close-growing crops, crop rotation, etc.

While terraces have not been used to any great extent in this watershed, the Soil Conservation Service, the State extension service, the Agricultural Adjustment Administration, and the Tallahatchie Soil Conservation District have attempted, with increasing success during recent years, to get terracing more generally accepted in the farm program.

The type of terrace most generally applicable in the watershed is one with a variable gradient; that is, the grade is level or almost level at the upper end and gradually increases along its length toward the outlet. The grade and cross section of the channel will be so constructed as not to induce an erosive velocity, and the size and shape of the terrace will permit easy cultivation throughout its entire area. The design will provide sufficient capacity to prevent destruction of the terrace by surface run-off from a rainfall of the maximum intensity to be expected during a 10-year period. The vertical interval between terraces will vary under different conditions of soil, slope, erosion,

etc., but it will never be great enough to permit the accumulation of water in sufficient volume or velocity to cause serious erosion.

The terracing system is not complete without adequately protected outlets. Extreme care will be exercised to protect terrace outlets with some type of heavy-duty vegetation, such as trees or pasture sod. It may often be necessary to reinforce natural drains or gullied areas for this purpose with perennial lespedeza, kudzu, or Bermuda grass; it may even be necessary to construct an outlet channel, reinforcing it with vegetation as indicated above. Terraces will be emptied into road ditches only as a last resort and then complete protection will be given the ditch.

Terraces are essential on all cultivated slopes with more than 1 percent gradient in the Little Tallahatchie watershed. Soil characteristics and erosion conditions limit successful intensive cultivation to slopes no steeper than about 8 percent in the Brown Loam and about 12 percent in the Pontotoc Ridge, the upper limits in the Clay Hills and Flatwoods being between these extremes. There are 77,068 [33] acres of agricultural land in the watershed within these slope ranges that will be terraced.

These terraces can be constructed either with mule-drawn equipment such as turning plows and V-drags, or with more modern power-drawn equipment. Although power machinery is more efficient, the former equipment is usually available on the farm, and hence seldom necessitates an outlay of actual cash (pl. 11). Cost of terracing by the method employing mule-drawn equipment totals about $5.55 per acre, of which $4.10 represents the cost of man and mule labor and $1.45 the cost of materials and supervision. The total cost of the terracing program amounts to $427,725.

To insure the continued efficient operation of the water-disposal system, terraces and outlets must be maintained constantly. This maintenance can be taken care of in the normal farming operations, but might require one extra plowing per year. Breaks and weak spots will be repaired immediately and deltas in the channels, caused by soil washing down from the interval above, will be removed to prevent ultimate total obstruction of the channel. Outlets will be examined frequently to replace vegetation and stop erosion. The annual cost of maintaining the terracing system, including outlets, will be approximately 60 cents per acre or a total of $46,240 annually after the entire program is installed.

Necessarily associated with the terracing system is the practice of contour tillage. It consists of cultivating the interval between terraces as nearly as possible on the contour, using the terrace as a guide; hence no added expense will be incurred in installing this essential practice.

Under certain conditions, when surface run-off from other areas flows onto adjacent lower cultivated land, it is necessary to construct a diversion terrace to divert water away from the cultivated land. Such terraces are somewhat similar to the conventional type used on cultivated land, but usually are more massive and have a greater cross-sectional area. The extent of diversion-terrace work is included as part of the terrace program for the cultivated land.

[33] This includes the portion of the nonagricultural area that is recommended for cultivation and requires terracing.

Critical area treatment.

In many cultivated fields there are small areas of steep slope or severe erosion, which are termed "critical areas." These are usually associated with an abrupt change in slope between two areas of more gentle topography. These critical areas, contributing excessive surface run-off and eroded material, are a constant menace to adjacent cropland, and untreated gullies originating here may encroach upon and ultimately destroy nearby lands. The major part of the gullying in the watershed is on or attributable to run-off from this type of land.

Such areas are not susceptible to control by ordinary methods of terracing, crop rotation, etc., since they require some type of permanent heavy-duty vegetation. Since these areas are rather small in extent and are intermingled with the cultivated land, they usually

PLATE 11.—Illustration of terrace construction with plow and mule power; this can be done by any farmer when terracing machinery is not available.

will be planted to a perennial hay crop such as kudzu or lespedeza rather than to trees or pasture grasses. These areas are poor planting sites because they have suffered severe erosion damage from past use. Care should be exercised in the preparation of the ground for planting, and fertilizer should be liberally applied while vegetation is being established. Since critical areas usually coincide with the contour of the land, treatment can often be correlated with the terracing system, devoting one or more terrace intervals to this purpose. Where more extensive areas have become critical, however, the entire area may be planted to perennial cover without constructing terraces.

Little or no return can be expected from critical areas during the period of their rehabilitation. However, once the crop is well established and care is used in cutting and in maintenance through fertilizing and occasional discing, returns in hay production and tem-

porary grazing will amply justify the necessary expenditure of time and money. In a few locations, where gully erosion has advanced to serious proportions, it is possible that no returns can ever be expected from the crops planted. The treatment of all critical areas, however, is necessary and well justified on the basis of protecting adjacent cropland, as well as the contribution made to reductions in surface run-off and prevention of sedimentation. This treatment will greatly reduce run-off, i. e., to about one twenty-fourth that from the original barren area.

Small or isolated critical areas, fence rows, waterways, field borders, etc., can be developed into feed and cover patches for wildlife by using various plants that are adapted to this use, such as common and perennial lespedeza, beggar weed, etc.

Within the agricultural area of the watershed there are 6,353 acres which should receive critical area treatment. The preparation, fertilization and planting of these areas, including field supervision, will cost an average of $11.80 per acre, of which $8.30 is for man-and-mule labor. The total cost of the work amounts to $74,965. Maintenance costs of $1.25 per acre annually will amount to a total of $7,940 each year after the program is installed.

Pasture development.

Past practice has been to cultivate land until it became so depleted and badly eroded that crops could no longer be produced, then to retire the area to "pasture" with no treatment whatsoever. Temporary, meager grazing and complete destruction of the topsoil can be the only results if land is so used. Surface run-off from these so-called pastures becomes progressively greater, often being 25 times as great as that from improved, well-sodded pasture. Thus, it is apparent that the development of good pastures is fully warranted as a flood-control measure. From the standpoint of farm economy, pasture development is a prerequisite to good livestock, which in turn is essential to a diversified and prosperous farm organization. Land which has gone through the cycle of cultivation and abandonment on account of depletion and advanced erosion is not easy to convert into good pasture, and this task will require years of intensive work. It will be possible, however, to develop and maintain a good pasture on nearly every farm in the agricultural area of the watershed with proper treatment. This improvement of pasture will increase the present carrying capacity of about 1 animal unit per 5.25 acres by at least 100 percent and often much more.

To develop a pasture it is necessary first to prepare the land for planting by breaking or discing the area into beds 6 to 8 feet wide which have been laid out on the contour. This operation provides a seedbed for planting and also establishes contour furrows which collect the major part of the surface run-off and allow it to seep into the ground where it can be utilized for plant growth. An application of about 500 pounds per acre of basic slag or some other equally good fertilizer will then be spread over the land and harrowed in. Seeding with a mixture of 10 pounds of common lespedeza, 8 pounds of Dallis grass, 3 pounds of white clover, and 2 pounds of hop clover per acre follows. Sprigs of Bermuda grass, usually obtainable on the farm, will be scattered about the pasture while seedbed preparation is in

progress; or a shallow furrow may be prepared along the contour bed and the sprigs placed in this and partly covered.

All pastures will be fenced to regulate grazing within the pasture and to prevent livestock from grazing adjacent or nearby woodland. Because very few pastures in the watershed are adequately fenced, this item constitutes an important part of the cost of pasture development. The actual grazing use must be so controlled as to permit optimum growing conditions for pasture plants.

In all, 62,982 [34] acres of land will be improved for pasture. All of it will require fencing (present fences are in bad repair or improperly located), 54,912 acres will require contouring, 38,389 acres will require fertilizing, and 37,012 acres will require seeding. Developing new pasture will cost as much as $18.16 per acre, but many areas will not require the full extent of work and the total cost will be $822,335 or an average of about $13 per acre.

Pasture maintenance involves control of grazing to prevent destruction of the basic pasture grasses and one to three annual clippings to destroy noxious weeds. Fertilizer will be applied at 3-year intervals (more often on poor soils); barren spots will be refertilized and reseeded; and contour furrows and fences will be kept in repair. This maintenance will cost $1.81 per acre annually (about 70 percent labor) and will amount to $114,000 annually after installation of the program.

Farm woodland treatment.

For purposes of flood-control planning, farm woodlands are considered as that portion of the agricultural area presently wooded and the open and cultivated land that should be planted to trees because of erosion or lowered productivity. This area, comprising approximately 180,000 acres, is important from a flood-control standpoint because of its extent and its present poor condition. No directed effort has been made to protect farm woodlands from fire, overgrazing, and excessive cutting, or to use them efficiently for the production of sawlogs, poles, pulpwood, fuel wood, etc. The custom has been to sell merchantable material whenever the opportunity offered, to use the woods as pasture the year round for whatever forage they provided, to permit or even practice woods burning at any season, and to consider any income produced as a boon entailing no effort or cost. This lack of appreciation of the proper use and management of farm woodlands during the past hundred years has produced a condition of greatly increased surface run-off and soil erosion and decreased productivity of the soil.

Treatment of nonforested land.

There are approximately 29,807 acres of open or abandoned land and 910 acres of steep cultivated land in the agricultural area that should revert to forest. Of this amount, it is estimated that approximately 10,649 acres will restock naturally to trees with adequate fire protection. There remain approximately 20,068 acres that must be artificially planted. This area to be planted consists of the poorest land on the farms and, like similar land in the nonagricultural area, generally requires expensive site preparation to assure an adequate stand of trees. In most cases, it will be necessary to build small inexpensive brush or vegetative dams in gullies, their function being

[34] This includes approximately 7,465 acres of land in the nonagricultural area that can be used for pasture.

to collect outwash soil which will afford planting sites for pine seedlings. Furthermore, kudzu will be planted where active headwall erosion is present or on small areas where such treatment will fit better into the farm program. In some areas gullying is so severe that it will be necessary to construct a diversion terrace or ditch around the head of the gully to divert the water from the gullied area itself or from adjacent cultivated fields. Several months after the site preparation work, a crew can plant the entire area to loblolly pine or some other suitable species. The methods used and the cost, $14 per acre, will be essentially the same as for the nonagricultural area. In connection with this treatment, 6 miles of diversion terraces will be required at a cost of about $60.50 per mile. The entire treatment on this area of 20,068 acres will cost $288,240.

After planting, some replanting and maintenance will be required, but this amount is included in the costs given. Once established, these planted areas will be managed according to methods much the same as those recommended for existing forests, although they may require even more vigilant protection from fire and marauding livestock, especially during the first 10 years.

Treatment of forested land.

The quality and volume of the farm woodlands have been reduced by overcutting to an average of about 800 board feet per acre of generally inferior species as compared to a potential volume under management of 16,000 board feet per acre of commercially valuable species. Approximately 12 percent of the area is at present inadequately stocked even for the production of homestead requirements of forest products. The present drain (amount cut for use) averages about 90 board feet per acre, 32 percent representing homestead requirements for fuel, fence posts, poles, and rough boards. This drain exceeds the current growth of approximately 70 board feet per acre by about 28 percent and, if continued in this ratio, will exhaust the timber resources and very seriously deplete the forest cover in a comparatively short time. The combined action of overcutting, excessive grazing, and uncontrolled burning has reduced the potential capacity of the woodland area to absorb and retain precipitation, retard and reduce surface run-off, and prevent or reduce soil erosion. In fact, these farm woodlands are in many cases in a more deteriorated condition than the forest lands in the nonagricultural area, although they are associated with land which can be kept permanently in agriculture, hence are an integral part of the farm economy and will be improved and developed accordingly.

As compared to other farm operations, the care and management of woodland is not understood by the farmer. Given certain technical assistance, the necessary measures will be inexpensive and will make minimum demands on the farmers' time and resources. On present woodland, they consist essentially of fire protection, controlled grazing, reduced cutting for a period (in accordance with a management plan), and improved marketing practices. An additional worthwhile practice is the planting of border strips of shrubs and grasses between woods and fields, to encourage wildlife.

Fire control will be attained through the over-all fire protection system for the watershed, the control of grazing will be attained by the development and fencing of improved pastures, and regulated cut-

ting and improved marketing conditions will be attained by providing technical assistance. Although fire protection will do much for flood control on these farm woodlands success will depend greatly on the extent to which the growing stock can be built up and the productive capacity restored. This will call for almost complete suspension of cutting during an initial period of about 20 years and rather strict adherence to a definite management plan and cutting budget which will, of course, allow for the cutting of sufficient trees to meet farm needs. Such a program requires, in addition to considerable educational effort, specific technical services which will aid and guide the farmer in a type of enterprise that essentially depends on voluntary cooperation. It will not be enough merely to prepare a management plan for the farmer and expect him to carry it out, especially since the program requires very conservative cutting to begin with. It will be necessary for technical foresters actually to mark timber for cutting and to make subsequent inspections, making sure that proper management practices were being successfully employed. This very important service cannot be performed by the present staff of Soil Conservation Service foresters in the watershed and at least four additional technical foresters will be assigned to do this work.

Technical assistance and administrative procedure.

The measures on agricultural land will be carried out in cooperation with the Little Tallahatchie Soil Conservation District, which embraces the entire watershed. The Department of Agriculture will negotiate an agreement with this district covering the arrangements under which the program will be applied to the lands of persons agreeing to participate in the program. The district will negotiate agreements with individuals providing for their participation in the program.

The detailed planning work will be undertaken by technical field representatives of the Department under the direction and supervision of their regional administrative organization. It is contemplated that approximately 3,500 farm owners will cooperate in the program during the 20-year installation period, thus about 175 farms involving about 14,000 acres will require individual surveys and plans annually. It is estimated that the work load imposed by the proposed program will necessitate the employment of technicians at an annual cost of $20,000. Four of these men will be technically trained in soils and farm planning work and four will be technical foresters qualified to develop and help effect forest management plans on farm woodlands. Necessary educational work to assure public acceptance of the proposed program will be provided through this addition of technical services. After the installation period, technical assistance for the farm-land program will be reduced to $10,000 annually.

Tenant-landlord arrangements.

Stability of tenure will be sought through improved contractual arrangements between landlord and tenant.

Summary of measures.

In determining the work load of the proposed flood-control program, full consideration was given to the work already accomplished on both farm land and nonagricultural areas by Federal, State, and local agencies, and the extent of work shown in the summary tables to follow does not include these items. No attempt was made to fore-

cast the volume of work which these agencies will accomplish through their regular programs in the future.

Wide differences in the soils, land use, slope, and stage of erosion make it necessary to adjust remedial measures to the physiographic areas, but since it is necessary to evaluate the program by drainage areas, the remedial program is summarized by the three tributary areas heretofore described.

Land-use changes in the agricultural area of the three tributary units will vary according to the acreage of the various physiographic areas occurring in each (table 12).

TABLE 12.—*Land-use changes proposed for the agricultural area*

Tributary area and present land use	Total	Future land use			
		Woodland	Cultivated	Pasture	20 percent not complying
Tallahatchie:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Woodland	86,489	69,190			17,299
Cultivated	132,212	377	102,012	3,381	26,442
Open land	65,845	13,264	8,028	31,384	13,169
Other [1]	4,198				4,198
Subtotal	288,744	82,831	110,040	34,765	61,108
Tippah:					
Woodland	33,096	26,478			6,618
Cultivated	35,959	365	27,104	1,298	7,192
Open land	19,385	5,263	2,605	7,640	3,877
Other [1]	1,639				1,639
Subtotal	90,079	32,106	29,709	8,938	19,326
Reservoir:					
Woodland	29,122	23,298			5,824
Cultivated	32,473	168	23,945	1,865	6,495
Open land	28,888	11,280	1,881	9,949	5,778
Other [1]	1,004				1,004
Subtotal	91,487	34,746	25,826	11,814	19,101
All areas:					
Woodland	148,707	118,966			29,741
Cultivated	200,644	910	153,061	6,544	40,129
Open land	114,118	29,807	12,514	48,973	22,824
Other [1]	6,841				6,841
Grand total	470,310	149,683	[2] 165,575	[2] 55,517	99,535

[1] Includes, lakes, towns, and rights-of-way.
[2] An additional 19,220 acres of cultivated land and 7,465 acres of pasture in the nonagricultural area will be in cultivation and pasture, respectively. See tables 17 and 19.

Of the 200,644 acres now being cultivated in the agricultural area of the watershed, 3 percent will be retired to pasture and less than 1 percent of woodland. Of the 114,118 acres of other open land, including existing pasture, 43 percent will be developed for pasture, 11 percent for cultivation, and 26 percent for woodland, the remaining 20 percent being the acreage in noncomplying ownerships. No changes are specified in the existing woodland. Such a large part of the agricultural land has been forced into abandonment because of advanced erosion that an acute shortage of land suitable for cultivation has been evident for a number of years. As a result, nearly all forest land that could possibly be used for cultivation has already been cleared, and no attempt was made to tabulate the small remnants of such land. It is recognized, however, that in planning the program on individual farms, some small areas of forest land will be found which can be cleared to replace cultivated land retired to other uses.

Installation of the remedial program in the agricultural area will entail treatment of 178,442 acres of cultivated land, 62,982 acres of pasture, and 20,068 acres of woodland (table 13). It will also require a labor output of 285,740 man-days distributed over a 20-year installation period, a total of 388,911 man-days of labor for maintenance of the measures during the same period, and 37,039 man-days each year thereafter (table 14).

Table 13.—*Quantitative requirements of measures applicable to the agricultural area*[1]

Kind of land and measure	Tallahatchie	Tippah	Reservoir	Total	Annually
Cultivated land:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Crop rotation	111, 748	33, 593	33, 101	178, 442	8, 922
Terracing	47, 641	11, 093	18, 334	77, 068	3, 854
Critical area treatment	4, 010	950	1, 393	6, 353	318
Pasture development:					
Contouring old pastures	15, 147	3, 997	4, 910	24, 054	1, 203
Contouring new pastures	16, 396	5, 131	9, 331	30, 858	1, 543
Seeding pastures	19, 219	6, 926	10, 867	37, 012	1, 851
Fertilizing pastures	20, 487	7, 035	10, 867	38, 389	1, 919
Fencing pastures	36, 400	10, 707	15, 875	62, 982	3, 149
Farm woodland treatment:					
Forest management	86, 489	33, 096	29, 122	148, 707	7, 435
Tree planting	7, 111	3, 876	9, 081	20, 068	1 003
	Hills (number)				
Kudzu planting in gullies	21, 209	2, 965	4, 908	29, 082	1, 454
	Dams (number)				
Dam construction	9, 610	2, 676	4, 075	16, 361	818
	Miles				
Diversion terraces	2. 5	1. 8	1. 8	6. 1	0. 305

[1] This includes the good farm land within the nonagricultural area. Period of installation is 20 years for all measures applicable to the agricultural area.

Table 14.—*Labor requirements for installation and maintenance of the remedial program on agricultural land*

Tributary area and treatment	Installation		Maintenance	
	Annual	Total	Total for 20-year period	Annual after twentieth year
Tallahatchie tributary area:	*Man-days*	*Man-days*	*Man-days*	*Man-days*
Cultivated land	4, 739	94, 780	95, 298	9, 076
Pasture development	2, 261	45, 220	135, 849	12, 938
Farm woodland treatment	956	19, 120		
Subtotal	7, 956	159, 120	231, 147	22, 014
Tippah tributary area:				
Cultivated land	1, 105	22, 100	22, 229	2, 117
Pasture development	694	13, 880	39, 963	3, 806
Farm woodland treatment	502	10, 040		
Subtotal	2, 301	46, 020	62, 192	5, 923
Reservoir tributary area:				
Cultivated land	1, 807	36, 140	36, 320	3, 459
Pasture development	1, 064	21, 280	59, 252	5, 643
Farm woodland treatment	1, 159	23, 180		
Subtotal	4, 030	80, 600	95, 572	9, 102
Total	14, 287	285, 740	388, 911	37, 039

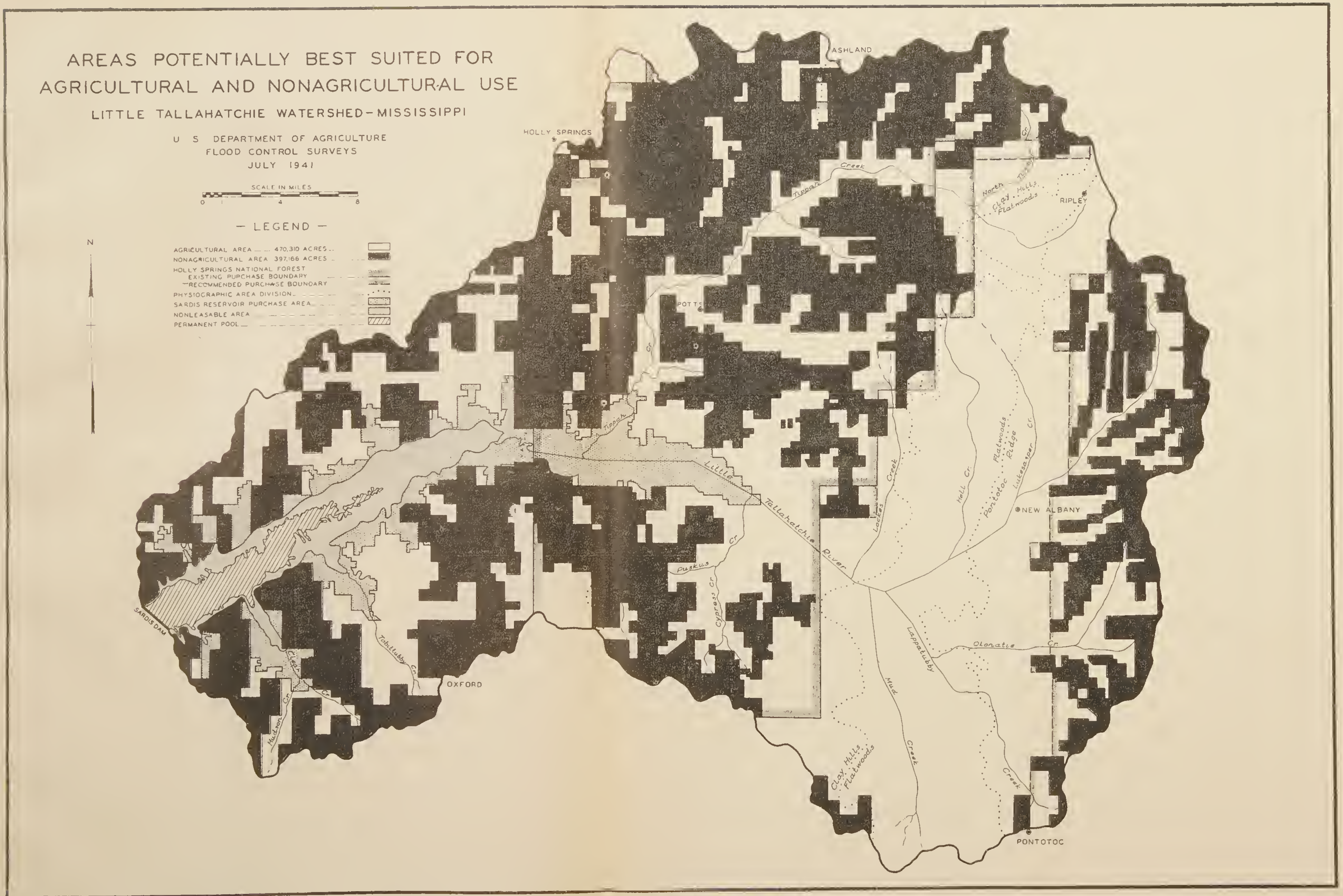

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FIGURE 8.

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MEASURES REQUIRED ON NONAGRICULTURAL LAND

The area designated as nonagricultural, totaling 392,158 acres, was examined in detail since it was recognized that some small parcels of good land were included, particularly in the stream bottoms, which should be continued in agricultural use. In formulating flood control measures, this portion of the nonagricultural area, comprising 33,353 acres, was therefore accorded the same remedial treatment as was planned for similar farm land in the agricultural area. There are actually, then, 358,805 acres, including 99,000 acres of national forest land of nonagricultural type (fig. 8) that will receive remedial treatment chiefly involving the establishment and maintenance of permanent watershed cover. At present, 70 percent of this land is already in woods, 5 percent is in cultivation, and 25 percent is open and abandoned, the latter being virtually destroyed (table 15).

TABLE 15.—*Present use of the nonagricultural land in the watershed*

Physiographic area [1]	Woodland		Cultivated		Open and other		Total
	Upland	Bottom land	Upland	Bottom land	Upland	Bottom land	
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Pontotoc Ridge	28, 723	167	3, 646	331	17, 426	221	50, 514
Clay Hills	140, 133	4, 978	5, 498	653	13, 841	1, 911	167, 014
Brown Loam	67, 907	7, 605	8, 983	992	54, 849	941	141, 277
All areas	236, 763	12, 750	18, 127	1, 976	86, 116	3, 073	358, 805
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Proportion of total	66	3½	5	½	24	1	100

[1] There is no land in the Flatwoods classified as nonagricultural.

It cannot be too strongly emphasized that the nonagricultural land (which is at present largely a part of the existing farm units) is in a deteriorated condition; the woodlands are badly understocked, burned, and overgrazed (pl. 12), the cultivated and pasture lands are on steep slopes with dep eted soils and have suffered various degrees of erosion (pls. 13 and 14), the open and abandoned land is practically ruined by erosion and denuded of vegetation (pl. 15). Furthermore, this class of land, as shown in figure 8, comprises extensive areas within which a permanent self-sustaining form of agriculture is hopeless, thus complicating the task of rehabilitating the plant cover under existing types of ownership and use. Living conditions indicate that incomes are much lower in the nonagricultural area (exclusive of the 33,353 acres of good agricultural land within the gross nonagricultural area) and are insufficient to support the people living therein adequately, even if it were possible to establish the same type of program as planned for the agricultural area.

This nonagricultural land has been so abused that it will take many years to establish a crop of timber that will produce an income sufficient to justify the cost of the remedial measures. The part that is now in forests is estimated to contain an average of only 800 board feet per acre as compared to a potential volume of 15,000 board feet.[35]

[35] It is estimated that somewhat more intensive management can be given farm woodlands than is possible on large blocks of national forest land; hence the difference in the potential volumes to be expected under the remedial program which rests on this consideration rather than any inherent differences in the productivity of the two classes of woodland.

PLATE 12.—Inadequately stocked woodland in the nonagricultural area of the Clay Hills.

PLATE 13.—Land abandoned from cultivation in the nonagricultural area.

PLATE 14.—Severely eroded pasture in the nonagricultural area of the Pontotoc Ridge; tree planting is the only satisfactory method of control for this area.

PLATE 15.—Open land finally abandoned from pasture in the nonagricultural area of the Brown Loam. Note the extent of this destroyed land; even to the hills in the background.

The present annual growth is only 70 board feet per acre, whereas the drain is 90 board feet. Restoration to adequate stocking will limit the cut for the next 60 years to 20 percent of the merchantable growth, and the present drain cannot be resumed for approximately 40 years. During this period taxes will continue and the expense of protection and management will further add to the costs. Although this class of land is perhaps in no worse condition than that of existing farm woodlands within the agricultural area, it, unlike the latter woodlands, is not intermingled or associated with farm ownerships that can be maintained permanently in agriculture, hence its treatment under a farm land program is largely out of the question and the commercial possibilities are not such as to attract other types of private ownership.

The open and abandoned lands present the most difficult problem of all. To check erosion and revegetate this area will require preparing sites and planting trees, constructing brush dams and diversion ditches, and planting kudzu or permanent vegetation on very severely gullied areas, as well as complete fire control. This treatment will cost more than $15 per acre on the average and would be prohibitive for the private owner to undertake. Regardless of the relatively great cost, these open lands must be treated if an effective flood-control program is to result.

Consideration was given to the possibility of a Federal subsidy sufficient to encourage the private landowner to treat this nonagricultural land, or the leasing of private land by the Federal Government for 50 or more years, during which period the land would be reforested and generally rehabilitated. Because of limitations of both of these procedures,[36] it is believed that the practical solution of the problem is Federal purchase of the land in question. The purchase and treatment of the nonagricultural land by the Federal Government should be done with full realization that for many years the probable benefits will be limited to reductions in flood and sediment damage on downstream areas. After 50 years, on-site benefits will begin to accrue in some magnitude from the sale of forest products and eventually the forest program will pay its way. On many areas, however, where site deterioration is far advanced, it may be impossible to establish anything more useful than watershed cover during the next century.

Land acquisition.

The Holly Springs National Forest has acquired approximately 99,000 acres within the nonagricultural area, 80,100 acres of which is in the Clay Hills. There remains within the Forest Service boundaries approximately 86,914 acres of nonagricultural land in the Clay Hills. Of this, however, an aggregate of 56,205 acres is in rather large blocks of forested land and the major specific measure necessary for flood control is protection from forest fires. This area, however, is generally cut over and the second-growth stands are in such poor condition that private interests cannot afford the investment necessary for management in view of the long-delayed returns. Thus, 56,205 acres should be acquired by the Holly Springs National Forest through the regular acquisition program and with regular Federal funds, but is not a part of the proposed remedial program.

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[36] See appendix, exhibit O.

The remaining 30,709 acres of nonagricultural land in the Clay Hills needs more intensive remedial treatment than fire control and will be acquired as part of the flood-control program to assure earlier treatment and more intensive maintenance of treatment than would result undeı the current acquisition and erosion control program of the Forest Service.

The nonagricultural land in the Pontotoc Ridge (50,514 acres) and Brown Loam (122,377 acres) is not contiguous forest land, but is an intermingled complex of badly understocked woodland, gullies, and open and abandoned land. This class of land, largely located outside the present boundaries of the national forest, will be wholly acquired and treated as part of the remedial program. Acquisition is not a prerequisite to achieving flood-control treatment of land in the Flatwoods.

To summarize, about 162,880 acres (80 percent of 203,600 acres) of nonagricultural land will be purchased as part of the flood-control program. All land purchased will be included in the national forest. Land purchases already made by the Forest Service in the watershed indicate an average cost per acre, including examinations and surveys, of approximately $6.70; thus, the total cost will be $1,091,300.

Treatment of forested land.

On the present wooded national forest land and the wooded land to be purchased for national forests, sound management practices will be applied. These include some timber stand improvement on areas where dominant noncommercial tree species or culls are retarding growth of advanced reproduction of commercial species, and selective logging that will ultimately transform the present depleted growing stock to a reasonably normal stand composed largely of desirable species. In some areas where site qualities have been depleted, it may be possible only to develop a forest suitable for watershed protection but of no commercial value. Methods advocated by the Forest Service include timber stand improvement where necessary, restricted cutting until the growing stock has been replenished, and selective logging to improve the composition of the forest stand and to maintain a protective watershed cover at all times. This conforms with flood-control requirements for treatment of forested land. The cost of this treatment is included under the heading "Technical assistance and administrative procedure."

Treatment of nonforested land.

With adequate fire control and management as described above, natural regeneration of forest trees will build up the growing stock in the present forest areas of the watershed. Many small fields and open areas will also be adequately reforested through natural processes, especially in the Pontotoc Ridge and Clay Hills, where seed trees are generally present. Artificial reforestation will be necessary, however, in areas where erosion has badly deteriorated the site or where seed trees are insufficient or of undesirable species.

From the standpoint of flood control, experience indicates that loblolly and shortleaf pine are best suited for the soils in this watershed in that they afford the earliest and best results in retarding surface run-off on the poor planting sites characteristic of the area (pls. 16 and 17).

Black locust has frequently been planted on gullied areas with poor results, and it is now generally recognized that this species should be planted only on the better sites. Although other hardwoods can be planted successfully on certain sites in this watershed, the results are uncertain, and none of these species is well adapted to the low-quality planting sites which require this treatment. It is, therefore, advisable to make estimates based on use of loblolly pine, but circumstances may require some variation of species in practice.

Planting costs range from $10.50 to $20.50 per acre, depending on the amount of site preparation that is necessary (appendix, exhibit M). On old fields or partially forested areas where erosion has not removed most of the topsoil, straight row planting with an ordinary planting bar will be possible at the lower cost. In many areas, however, it will be necessary to construct small inexpensive soil catchment dams or trenches and diversion ditches around the heads of gullies. After a few rains, the dams or trenches will collect a pocket of outwash soil in which pine seedlings can be planted. Some replanting will be necessary when adverse weather or other factors reduce the survival below a satisfactory stand, which for flood-control planning purposes is fixed at 80 percent of the planted trees at the end of the second year. Taking all of the factors mentioned into consideration, the plantable area was sampled to determine the range and extent of site qualities, and the average planting cost was found to be $14 per acre.

It was determined that artificial planting in the nonagricultural area is necessary (deducting 20 percent for land which cannot be acquired for treatment) on 11,646 acres in the Pontotoc Ridge, 8,649 acres in the Clay Hills, and 45,192 acres in the Brown Loam, a total of 65,487 acres. Approximately 97 percent of this land is open and subject to severe sheet or gully erosion; it can be revegetated satisfactorily only with tree growth. The total cost of tree planting in the nonagricultural area amounts to $916,820. In addition to the tree planting, a total of 79,934 site-preparation dams costing $27,977 and 5.7 miles of diversion ditches costing $344 will be necessary. Also, some extremely large gullies in the nonagricultural area require more than reforestation if proper reduction in surface run-off and silting is to be attained at a reasonable cost. These gullies are the caving head-wall type where erosion is very active and special difficulty is experienced in establishing trees. Here, 2-year-old kudzu plants will be established, care being taken to avoid planting them among or too near pine seedlings. This is the cheapest method of stabilizing caving types of gullying, requiring approximately 357,725 hills of kudzu at a cost of $14,667.

Technical assistance and administrative procedure.

The acquisition and administration of the land in the nonagricultural area will be handled by the Forest Service as an expansion of the Holly Springs National Forest. The expanded work load on the administrative force of the Forest Service resulting from the program will be financed from Federal funds provided to finance this remedial program during and after the installation period. This administrative cost amounts to 10½ cents per acre and is estimated to be $12,000

per year from the fifth to twentieth year, totaling $180,000 [37] during the installation period, and $17,100 annually thereafter.

In the process of acquisition of the nonagricultural land, the potential use of each small tract will be determined. Good agricultural land will be so designated and reserved for cultivation or pasture after the tract is purchased. The nonagricultural land will be given the wildland treatment immediately and the good agricultural land will be leased as cropland or pasture. If practicable, of course, the better land will remain in private ownership.

There are approximately 966 farms in the nonagricultural area, most of them dependent on the 33,353 acres of good agricultural land. Because this good land is scattered, opportunities for about 166 farms exist in the area. There remain 640 farms (based on 80 percent

PLATE 16.—A loblolly pine plantation on severely eroded land in the Pontotoc Ridge.

participation) that will be purchased. About one-fourth of these farms, however, especially in the Pontotoc Ridge, have much of their land in the agricultural area in the bottom lands although the farm buildings stand on the nonagricultural land of the ridges. Where this arrangement exists, the owners can retain their homesites and no resettlement problem will be involved. There remain, therefore, approximately 480 farms on which the people will have to be relocated during the 20-year period, an average of about 24 farms per year, or an estimated 40 families as more than 1 family lives on some farms. The Department will offer every possible assistance to assure proper relocation of these families. No families will be forced to move until a better location is found and all sale of land will be voluntary on the

[37] Actually, on a straight-line basis, the administrative cost would increase each year as additional acreage would be acquired, being $855 the first year and increasing annually until it leveled off at $17,100 the twentieth year. Practically, however, expansion in administrative costs will occur periodically as indicated.

part of the owner. The cost of relocating these farmers will be covered in the technical supervision costs set up for the nonagricultural area.

In purchasing the nonagricultural land, there will inevitably be acquired small areas of land suitable for continuous agriculture. These tracts will be treated in accordance with recommendations

PLATE 17.—Old-field stand of shortleaf pine 55 years old that has completely reclaimed a gullied cottonfield.

heretofore given for cultivated land and pasture. After improvement, they will be leased to nearby farmers, preferably those cooperating in the flood-control program on the adjacent agricultural land. The lease will be of the Forest Service annual type, which permits renewal as long as the terms of the lease are fulfilled, and which in this instance will make renewal contingent on maintaining all measures.

Summary of measures.

The program for the nonagricultural area involves the purchase of 162,880 acres of land; reforestation, including simple gully-control work, on 65,487 acres; and continued management and protection of these areas (table 16).

TABLE 16.—*Quantitative requirements of measures applicable to the nonagricultural area* [1]

Tributary area	Forest management [2]	Land acquisition	Nonforested land: Tree planting	Nonforested land: Kudzu planting [3]	Nonforested land: Brush dam construction [3]	Nonforested land: Diversion terraces
	Acres	*Acres*	*Acres*	*Hills*	*Number*	*Miles*
Tallahatchie	47, 341	47, 341	14, 608	185, 420	16, 226	2. 5
Tippah	32, 454	32, 454	13, 321	44, 974	17, 089	1. 6
Reservoir	83, 085	83, 085	37, 558	127, 331	46, 619	1. 6
Total	162, 880	162, 880	65, 487	357, 725	79, 934	5. 7
Annually	8, 144	8, 144	3, 274	17, 886	3, 997	. 285

[1] Period of installation is 20 years for all measures applicable to the nonagricultural area.
[2] Does not include 99,000 acres presently owned by the Forest Service, or the 44,964 (80 percent of 56,205) acres to be acquired by the Forest Service in its regular acquisition program.
[3] In gullies.

This program will require a conversion of land use increasing the woodland acreage from 249,513 acres to 336,945 acres, the difference coming from retirement to forests of 16,084 acres of cultivated land and 71,348 acres of open land. Approximately 8,729 acres will remain in cultivation and 19,799 acres will remain in open land, owing to expected lack of cooperation on the part of the owners (table 17). The annual labor requirement for the 20-year period would be 8,814 man-days (table 18).

TABLE 17.—*Land-use changes proposed in the nonagricultural area*

Tributary area and present land use	Total	Future land use: Woodland	Future land use: Cultivated [1]	Future land use: Pasture [1]	Future land use: 20-percent noncompliance
Tallahatchie:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Woodland	74, 927	59, 942	0	0	14, 985
Cultivated	13, 240	4, 840	4, 764	989	2, 647
Open land	23, 594	17, 275	954	646	4, 719
Other [2]	1, 252	0	0	0	1, 252
Subtotal	113, 013	82, 057	5, 718	1, 635	23, 603
Tippah:					
Woodland	106, 576	85, 260	0	0	21, 316
Cultivated	10, 876	4, 525	3, 560	616	2, 175
Open land	23, 205	16, 137	1, 274	1, 153	4, 641
Other [2]	1, 690	0	0	0	1, 690
Subtotal	142, 347	105, 922	4, 834	1, 769	29, 822
Reservoir:					
Woodland	68, 010	54, 408	0	0	13, 602
Cultivated	19, 535	6, 719	7, 213	1, 696	3, 907
Open land	52, 195	37, 936	1, 455	2, 365	10, 439
Other [2]	2, 066	0	0	0	2, 066
Subtotal	141, 806	99, 063	8, 668	4, 061	30, 014
All areas:					
Woodland	249, 513	199, 610	0	0	49, 903
Cultivated	43, 651	16, 084	15, 537	3, 301	8, 729
Open land	98, 994	71, 348	3, 683	4, 164	19, 799
Other [2]	5, 008	0	0	0	5, 008
Grand total	397, 166	287, 042	19, 220	7, 465	83, 439

[1] Treatment for these intermingled areas is described and included under measures on agricultural land.
[2] Includes towns, lakes, and rights-of-way.

TABLE 18.—*Labor requirements for installation of the remedial program on nonagricultural land*

Tributary area	Annual	Total
	Man-days	*Man-days*
Tallahatchie	2,004	40,080
Tippah	1,786	35,720
Reservoir	5,024	100,480
Total	8,814	176,280

The program for nonagricultural land is a program that will return very small on-site benefits for many years to come, but it will be the backbone of a flood-control program in the Little Tallahatchie watershed and the flood-control benefits will be great. The net effect on the general economy of the watershed will be favorable. Such a program will tend to enhance the value of the agricultural area, inasmuch as it will relieve the private owner of the expense and care of much land that is at present furnishing no returns.

SUMMARY OF THE WATERSHED PROGRAM

The proposed remedial program will result in an increase for the watershed as a whole of woodland from 398,220 acres to 516,369 acres; a slight decrease in cultivated land from 244,295 to 233,353 acres, and the development of 62,982 acres of improved pasture land, very little of which exists at present (table 19). Fire protection and forest management will be applied to woodland, cultivated land will be treated with proper conservation measures, pastures will be developed wherever feasible, and open and abandoned land will be utilized as fully as possible (table 20). The program will require 675,765 man-days of labor for installation, 500,751 man-days of labor for maintenance during the installation program, and 42,631 man-days labor annually thereafter (table 21). Roughly, this would amount to the employment of around 200 men full time during the installation period and about 150 thereafter, although actually the work will be divided among those needing work in the area.

TABLE 19.—*Land-use changes effected by the proposed program on the watershed*

Tributary area and present land use	Total	Future land use			
		Woodland	Cultivated	Pasture	20-percent noncompliance no change
Tallahatchie:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Woodland	161,416	129,132	0	0	32,284
Cultivated	145,452	5,217	106,776	4,370	29,089
Open land	89,439	30,539	8,982	32,030	17,888
Other [1]	5,450	0	0	0	5,450
Subtotal	401,757	164,888	115,758	36,400	84,711
Tippah:					
Woodland	139,672	111,738	0	0	27,934
Cultivated	46,835	4,890	30,664	1,914	9,367
Open land	42,590	31,400	3,879	8,793	8,518
Other [1]	3,329	0	0	0	3,329
Subtotal	232,426	138,028	34,543	10,707	49,148

TABLE 19.—*Land-use changes effected by the proposed program on the watershed*—Continued

Tributary area and present land use	Total	Future land use			
		Woodland	Cultivated	Pasture	20-percent noncompliance no change
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Reservoir:					
Woodland	97, 132	77, 706	0	0	19, 426
Cultivated	52, 008	6, 887	31, 158	3, 561	10, 402
Open land	81, 083	49, 216	3, 336	12, 314	16, 217
Other [1]	3, 070	0	0	0	3, 070
Subtotal	233, 293	133, 809	34, 494	15, 875	49, 115
All areas:					
Woodland	398, 220	318, 576	0	0	79, 644
Cultivated	244, 295	16, 994	168, 598	9, 845	48, 858
Open land	213, 112	101, 155	16, 197	53, 137	42, 623
Other [1]	11, 849	0	0	0	11, 849
Grand total	867, 476	436, 725	184, 795	62, 982	182, 974

[1] Includes towns, lakes, and rights-of-way.

TABLE 20.—*Quantitative requirements of measures for the remedial program*

Kind of land and measure	Tributary area			Watershed
	Tallahatchie	Tippah	Reservoir	
	Acres			
Fire protection [1]	303, 370	48, 912	224, 843	577, 125
Cultivated land:				
Crop rotation	111, 748	33, 593	33, 101	178, 442
Terracing	47, 641	11, 093	18, 334	77, 068
Critical area treatment	4, 010	950	1, 393	6, 353
Pasture development:				
Contouring old pastures	15, 147	3, 997	4, 910	24, 054
Contouring new pastures	16, 396	5, 131	9, 331	30, 858
Seeding pastures	19, 219	6, 926	10, 867	37, 012
Fertilizing pastures	20, 487	7, 035	10, 867	38, 389
Fencing pastures	36, 400	10, 707	15, 875	62, 982
Farm woodland management	86, 489	33, 096	29, 122	148, 707
Land acquisition	47, 341	32, 454	83, 085	162, 880
Forest management (national forest)	47, 341	32, 454	83, 085	162, 880
Tree planting [1]	21, 719	17, 197	46, 639	85, 555
	Hills			
Kudzu planting [1]	206, 629	47, 939	132, 239	386, 807
	Number			
Dam construction [1]	25, 836	19, 765	50, 694	96, 295
	Miles			
Diversion terraces [1]	5	3. 4	3. 4	11. 8
Roadbank stabilization	691	312	397	1, 400

[1] Includes private and Federal land.

TABLE 21.—*Labor requirements for installation and maintenance of the remedial program*

Tributary area	Installation	Maintenance	
		Total for 20-year period	Annual after twentieth year
	Man-days		
Tallahatchie	304, 965	271, 847	24, 049
Tippah	128, 235	86, 832	7, 155
Reservoir	242, 565	142, 072	11, 427
Watershed	675, 765	500, 751	42, 631

CHAPTER V. COST OF THE REMEDIAL PROGRAM

INSTALLATION COSTS

The entire flood-control program as heretofore outlined can be installed on the watershed in approximately 20 years at a total cost of $5,916,805 or $6.82 per acre. This is made up of $2,525,470 or $6.29 per acre on the Tallahatchie tributary area, $1,142,005 or $4.91 per acre on Tippah tributary area, and $2,249,330 or $9.64 per acre on the reservoir tributary area (table 22).

Of the total installation cost of the program, $4,220,805 or 71 percent will come from Federal funds, $472,080 or 8 percent will come from State and local government funds, and $1,223,920 or 21 percent will be the contribution of the private landowner. The last amount represents, for the most part, the value of labor and materials that can be furnished from the farm.[38]

Treatment of cultivated land, pasture, and farm woodland will account for approximately 34 percent of the total costs, land acquisition will require about 18 percent, treatment of acquired land approximately 16 percent, roadbank stabilization about 13 percent, fire control less than 2 percent, and the remaining items approximately 17 percent (table 23).

In order to determine the physical requirements for installing the program, costs of labor, materials, and supervision were calculated separately. Approximately 49 percent of the cost of the remedial program will be accounted for by materials, much of which would come from the farm, 31 percent would be human labor, 17 percent technical and field supervision, and 3 percent the cost of mule labor (table 24).

[38] Refer to appendix, exhibit M, for basis of cost allocation.

TABLE 22.—*Cost of installation of the remedial program by source of funds, Little Tallahatchie watershed*

Tributary area	Measure	Annual cost, first 5 years				Total for 5-year period	Annual cost, next 15 years			Total for 15-year period	Grand total cost
		Federal	State and local governments	Private	Total annual		Federal	Private	Total annual		
Tallahatchie	Measures applicable to the entire watershed:										
	Fire protection	$8, 495			$8, 495	$42, 475					$42, 475
	Roadbank stabilization	24, 525	$53, 143		77, 668	388, 340					388, 340
	Measures on agricultural land:										
	Cultivated, pasture, and woodland	19, 795		$36, 729	56, 524	282, 620	$19, 796	$36, 728	$56, 524	$847, 860	1, 130, 480
	Technical planning and supervision	12, 000			12, 000	60, 000	12, 000		12, 000	180, 000	240, 000
	Measures on nonagricultural land:										
	Land acquisition	15, 859			15, 859	79, 295	15, 859		15, 859	237, 885	317, 180
	Treatment of acquired land	10, 898			10, 898	54, 490	10, 897		10, 897	163, 455	217, 945
	Technical planning and supervision						3, 360		3, 360	50, 400	50, 400
	Contingency	9, 157			9, 157	45, 785	6, 191		6, 191	92, 865	138, 650
	Total	100, 729	53, 143	36, 729	190, 601	953, 005	68, 103	36, 728	104, 831	1, 572, 465	2, 525, 470
Tippah	Measures applicable to the entire watershed:										
	Fire protection	1, 370			1, 370	6, 850					6, 850
	Roadbank stabilization	20, 502	14, 567		35, 069	175, 345					175, 345
	Measures on agricultural land:										
	Cultivated, pasture, and woodland	7, 266		10, 418	17, 684	88, 420	7, 266	10, 418	17, 684	265, 260	353, 680
	Technical planning and supervision	4, 000			4, 000	20, 000	4, 000		4, 000	60, 000	80, 000
	Measures on nonagricultural land:										
	Land acquisition	10, 873			10, 873	54, 365	10, 873		10, 873	163, 095	217, 460
	Treatment of acquired land	9, 720			9, 720	48, 600	9, 721		9, 721	145, 815	194, 415
	Technical planning and supervision						2, 400		2, 400	36, 000	36, 000
	Contingency	5, 373			5, 373	26, 865	3, 426		3, 426	51, 390	78, 255
	Total	59, 104	14, 567	10, 418	84, 089	420, 445	37, 686	10, 418	48, 104	721, 560	1, 142, 005

TABLE 22.—*Cost of installation of the remedial program by source of funds, Little Tallahatchie watershed*—Continued

Tributary area	Measure	Annual cost, first 5 years				Total for 5-year period	Annual cost, next 15 years			Total for 15-year period	Grand total cost
		Federal	State and local governments	Private	Total annual		Federal	Private	Total annual		
Reservoir	Measures applicable to the entire area:										
	Fire protection	$6, 295			$6, 295	$31, 475					$31, 475
	Roadbank stabilization	17, 917	$26, 706		44, 623	223, 115					223, 115
	Measures on agricultural land:										
	Cultivated, pasture, and woodland	13, 461		$14, 049	27, 510	137, 560	$13, 462	$14, 050	$27, 512	$412, 680	550, 230
	Technical planning and supervision	4, 000			4, 000	20, 000	4, 000		4, 000	60, 000	80, 000
	Measures on nonagricultural land:										
	Land acquisition	27, 833			27, 833	139, 165	27, 833		27, 833	417, 495	556, 660
	Treatment of acquired land	27, 373			27, 373	136, 865	27, 372		27, 372	410, 580	547, 445
	Technical planning and supervision						6, 240		6, 240	93, 600	93, 600
	Contingency	9, 688			9, 688	48, 440	7, 891		7, 891	118, 365	166, 805
	Total	106, 567	26, 706	14, 049	147, 322	736, 610	86, 798	14, 050	100, 848	1, 512, 720	2, 249, 330
Watershed	Measures applicable to the entire area	79, 104	94, 416		173, 520	867, 600					867, 600
	Measures on agricultural land	60, 522		61, 196	121, 718	608, 590	60, 524	61, 196	121, 720	1, 825, 800	2, 434, 390
	Measures on nonagricultural land	102, 556			102, 556	512, 780	114, 555		114, 555	1, 718, 325	2, 231, 105
	Contingency	24, 218			24, 218	121, 090	17, 508		17, 508	262, 620	383, 710
	Grand total	266, 400	94, 416	61, 196	422, 012	2, 110, 060	192, 587	61, 196	253, 783	3, 806, 745	5, 916, 805

TABLE 23.—*Summary of installation costs by measures*

Measure	Total amount	Distribution
		Percent
Fire control	$80,800	1.4
Roadbank stabilization	786,800	13.3
Cultivated, pasture, and farm woodland	2,034,390	34.4
Acquisition of land	1,091,300	18.4
Treatment of acquired land	959,805	16.2
Technical planning and supervision	580,000	9.8
Contingency	383,710	6.5
Total	5,916,805	100.0

TABLE 24.—*Break-down of installation costs by measures, Little Tallahatchie watershed*

Type of land and measure	Unit	Number of units	Unit cost	Total cost	Cost break-down: Man-days	Mule-days	Materials [1]	Field supervision and education
Measures applicable to the entire watershed:								
Fire protection	Acre	577, 125	$0. 14	$80, 800	$23, 085		$57, 715	
Roadbank stabilization	Mile	1, 400	562. 00	786, 800	575, 400		109, 200	$102, 200
Total				867, 600	598, 485		166, 915	102, 200
Measures on agricultural land:								
Cultivated land:								
Crop rotation	Acre	178, 442	2. 36	421, 125			421, 125	
Terracing	Acre	77, 068	5. 55	427, 725	208, 085	$107, 895	80, 920	30, 825
Critical area treatment	Acre	6, 353	11. 80	74, 965	40, 025	12, 705	20, 645	1, 590
Subtotal				923, 815	248, 110	120, 600	522, 690	32, 415
Pasture development:								
Contouring old pastures	Acre	24, 054	2. 69	64, 705	40, 410	23, 090		1, 205
Contouring new pastures	Acre	30, 858	2. 69	83, 005	51, 840	29, 625		1, 540
Seeding pastures	Acre	37, 012	7. 80	288, 695	12, 955		273, 890	1, 850
Fertilizing pastures	Acre	38, 389	3. 95	151, 635	53, 745		95, 970	1, 920
Fencing pastures	Acre	62, 982	3. 72	234, 295	66, 130		161, 865	6, 300
Subtotal				822, 335	225, 080	52, 715	531, 725	12, 815
Farm woodland treatment:								
Tree planting	Acre	20, 068	14. 00	280, 955	139, 875		138, 470	2, 610
Kudzu planting in gullies	Hill	29, 082	. 041	1, 190	725		350	115
Brush dam construction	Each	16, 361	. 35	5, 725	5, 725			
Diversion terraces	Mile	6. 1	60. 50	370	215	110	30	15
Subtotal				288, 240	146, 540	110	138, 850	2, 740
Technical planning and supervision				400, 000				400, 000
Total agricultural land				2, 434, 390	619, 730	173, 425	1, 193, 265	447, 970
Measures on nonagricultural land:								
Land acquisition	Acre	162, 880	6. 70	1, 091, 300			895, 850	195, 450
Technical planning and supervision				180, 000				180, 000
Nonforested land:								
Tree planting	Acre	65, 487	14. 00	916, 820	456, 445		451, 860	8, 515
Kudzu planting in gullies	Hill	357, 725	. 041	14, 665	8, 940		4, 295	1, 430
Brush dam construction	Each	79, 934	. 35	27, 975	27, 975			
Diversion terraces	Mile	5. 7	60. 50	345	200	100	30	15
Total nonagricultural land				2, 231, 105	493, 560	100	1, 352, 035	385, 410
Grand total				[2] 5, 533, 095	1, 711, 775	173, 525	2, 712, 215	935, 580
Percent of total				100	31	3	49	17

[1] The expected price of land to be acquired is included under materials.

[2] This does not include 10-percent contingency of Federal funds.

MAINTENANCE AND OPERATION COSTS

The total cost of operations and maintenance for the 20-year installation period will be $4,525,430, of which $2,663,165 is for the Tallahatchie tributary area, $818,735 for the Tippah tributary area, and $1,043,530 for the Reservoir tributary area (table 25).

After the installation period, the annual maintenance and operations costs will be approximately $372,690 for the Tallahatchie, $116,385 for the Tippah, and $140,130 for the Reservoir area.

During and after the installation period, private funds will bear 91 percent of the operations and maintenance costs and Federal funds 9 percent.

The maintenance and operation costs of the fire protection system will total $417,495 during the 20-year installation period and $20,875 annually thereafter. On agricultural land the operation and maintenance costs will total $4,507,935 during the first 20 years and $401,230 annually thereafter. These maintenance and operation costs will be approximately 44 percent labor and 56 percent material cost during the installation period and 39 percent and 61 percent, respectively, after the installation period (table 26).

ANNUAL FINANCIAL REQUIREMENTS, INSTALLATION, MAINTENANCE, AND OPERATION

For the first 5 years of the proposed program, Federal funds will be needed in the amount of $287,274 annually; for the next 15 years this will amount to $213,462 annually. After the twentieth year, an annual sum of $41,695 will be necessary to assure continued fire protection and management on forest and farm land in the watershed. A private expenditure of $82,768, of which labor and materials constitute about 48 percent, will be needed for the first year of the program. This will increase annually as maintenance requirements increase, until it reaches $450,417 in the twentieth year. Thereafter, annual private costs will become $397,510 of which about one-third will be labor and materials (table 27).

The total necessary for the complete program, including operations and maintenance, will be $464,458 the first year and will increase to $541,858 in the fifth year. The requirement will drop to $392,980 in the sixth year because of completion of the roadbank stabilization work and the fire control system. The costs of the program will then gradually increase to $663,879 in the twentieth year as added operations and maintenance costs will be incurred. After the twentieth year, the entire program will be installed and the annual operations and maintenance costs will level off at $439,205.

TABLE 25.—*Cost of maintenance and operation of remedial program by source of funds, Little Tallahatchie watershed*

Tributary area and type of measure	Total cost, first 20 years		Total for 20-year period	Annual cost after twentieth year		
	Federal	Private		Federal	Private	Total annual
Tallahatchie:						
Fire protection	$151, 920		$151, 920	$5, 995	$2, 560	$8, 555
Cultivated, pasture, and woodland		$2, 511, 245	2, 511, 245		239, 165	239, 165
Technical supervision				10, 970		10, 970
Subtotal	151, 920	2, 511, 245	2, 663, 165	16, 965	241, 725	258, 690
Tippah:						
Fire protection	91, 985		91, 985	2, 625	1, 135	3, 760
Cultivated, pasture, and woodland		726, 750	726, 750		69, 215	69, 215
Technical supervision				5, 410		5, 410
Subtotal	91, 985	726, 750	818, 735	8, 035	70, 350	78, 385
Reservoir:						
Fire protection	173, 590		173, 590	5, 975	2, 585	8, 560
Cultivated, pasture, and woodland		869, 940	869, 940		82, 850	82, 850
Technical supervision				10, 720		10, 720
Subtotal	173, 590	869, 940	1, 043, 530	16, 695	85, 435	102, 130
Watershed:						
Fire protection	417, 495		417, 495	14, 595	6, 280	20, 875
Cultivated, pasture, and woodland		4, 107, 935	4, 107, 935		391, 230	391, 230
Technical supervision				27, 100		27, 100
Grand total	417, 495	4, 107, 935	4, 525, 430	41, 695	397, 510	439, 205
Percent of total	9	91	100	9	91	100

TABLE 26.—*Break-down of maintenance costs by measures, Little Tallahatchie watershed*

Measure	Unit	Number of units	Unit cost annual	Total for first 20 years			Annual cost after twentieth year		
				Labor	Material	Total	Labor	Material	Total
Measures applicable to the entire watershed: Fire protection, total.	Acre	521, 870	0. 04	$313, 125	$104, 370	$417, 495	$15, 655	$5, 220	$20, 875
Measures on agricultural land:									
Cultivated land:									
Crop rotation	Acre	178, 442	1. 25		2, 342, 055	2, 342, 055		223, 050	223, 050
Terracing	Acre	77, 068	. 60	485, 520		485, 520	46, 240		46, 240
Critical area treatment.	Acre	6, 353	1. 25	50, 030	33, 355	83, 385	4, 765	3, 175	7, 940
Total				535, 550	2, 375, 410	2, 910, 960	51, 005	226, 225	227, 230
Pasture development	Acre	62, 982	1. 81	820, 030	376, 945	1, 196, 975	78, 095	35, 905	114, 000
Technical supervision				400, 000		400, 000	10, 000		10, 000
Total agricultural land.				1, 755, 580	2, 752, 355	4, 507, 935	139, 100	262, 130	401, 230
Measures on nonagricultural land: Technical supervision.	Acre	162, 880	. 105	180, 000		180, 000	17, 100		17, 100
Grand total				2, 248, 705	2, 856, 725	5, 105, 430	171, 855	267, 350	439, 205
Percent of total				44	56	100	39	61	100

TABLE 27.—*Annual requirement of funds by sources for installation and maintenance of flood control remedial program, Little Tallahatchie watershed*

Year	Source of funds					Grand total costs
	Federal funds	State and local government	Private			
			In cash	In labor and material	Total	
1	$287, 274	$94, 416	$43, 230	$39, 538	$82, 768	$464, 458
2	287, 274	94, 416	55, 685	46, 433	102, 118	483, 808
3	287, 274	94, 416	68, 131	53, 337	121, 468	503, 158
4	287, 274	94, 416	80, 590	60, 228	140, 818	522, 508
5	287, 274	94, 416	93, 042	67, 126	160, 168	541, 858
6	213, 462		105, 485	74, 033	179, 518	392, 980
7	213, 462		117, 949	80, 919	198, 868	412, 330
8	213, 462		130, 407	87, 811	218, 218	431, 680
9	213, 462		142, 850	94, 718	237, 568	451, 030
10	213, 462		155, 307	101, 611	256, 918	470, 380
11	213, 462		167, 750	108, 518	276, 268	489, 730
12	213, 462		180, 209	115, 409	295, 618	509, 080
13	213, 462		192, 666	122, 302	314, 968	528, 430
14	213, 462		205, 104	129, 214	334, 318	547, 780
15	213, 462		217, 577	136, 091	353, 668	567, 130
16	213, 462		230, 002	143, 015	373, 017	586, 479
17	213, 462		242, 444	149, 923	392, 367	605, 829
18	213, 462		254, 935	156, 782	411, 717	625, 179
19	213, 462		267, 348	163, 719	431, 067	644, 529
20	213, 462		279, 799	170, 618	450, 417	663, 879
Total	4, 638, 300	472, 080	3, 230, 510	2, 101, 345	5, 331, 855	10, 442, 235
21 and thereafter	41, 695		262, 130	129, 100	397, 510	439, 205

CHAPTER VI. BENEFITS OF THE REMEDIAL PROGRAM

In the Department of Agriculture's flood-control program, the costs of an upstream program and the value of reductions in flood and sediment damages to be attained on valley lands are of primary importance. There are additional benefits, perhaps fully as important in the development and economy of a drainage basin, which also should be evaluated. These are the conservation benefits to the upland flood-contributing areas on which the measures are applied and largely represent increased crop or timber yields or other enhanced values. The calculated benefits of the remedial program, along with a brief description of their determination, will be presented in this chapter.

BENEFITS TO VALLEY LANDS

The reductions in flooding and sedimentation ascribable to the recommended program represent annual benefits of $337,727 [39] on the affected bottom lands. These consist of benefits from (1) reduced floodwater damage to crops, farm property, roads, bridges, and railroads; (2) reduction of sediment damage to flood-plain lands; (3) alleviation of past sediment damage; (4) reduction of siltation of the Sardis Reservoir; and (5) reduction of indirect damages. Because the physical processes of flooding and sedimentation differ, the methods of evaluating the benefits vary somewhat and are discussed separately.

[39] Represents the annual equivalent of the present worth of future flood and sedimentation benefits.

Flood reductions and benefits.

Of the total $337,727 annual flood and sediment benefits $137,721 are the calculated benefits to accrue from the reduction of floodwater damage to crops, farm property, roads, bridges, and railroads. The general method of calculating these benefits was as follows: First, to establish for the 10-year period 1929–38 a series of floods comparable to those occurring on the streams of the Little Tallahatchie watershed; second, to calculate the flood damages that would have resulted from this series of floods; third, to establish a new series of floods differing from the original series only in the reduced volumes effected by the remedial program; fourth, to recalculate by the same procedure the damages from the new series of floods; and finally, to determine the difference between the two damage figures, which is the total flood-reduction benefits for the 10-year period. Benefits were computed separately for the Tallahatchie, Tippah, and Reservoir tributary areas.

Calculation of flood reductions and benefits.[40]—Calculation of the benefits for the three tributary areas was based on flood reductions in each of those areas. Separate computations were made for the minor tributaries and for Tippah Creek and Little Tallahatchie River, the major tributaries.[41] Briefly, the method consisted of selecting a total of eight minor streams as representative samples of groups of minor tributaries in the four physiographic areas (fig. 9) and computing the flood volumes, crests, durations, and areas inundated for each of these sample streams, both without and with the program, for all floods during the 10-year evaluation period. The same method was followed for the two main stems except that these were treated separately, constituting in each instance nearly a 100-percent sample.

Flood-volume reductions were computed on the basis of the increased infiltration capacities that will obtain after the installation of the remedial program. This involved the determination of infiltration-capacities for each soil-cover complex within the drainage basin now and after the program is in effect. Infiltration-capacities were ascertained through about 300 infiltrometer tests on 4 soil types and 12 cover conditions. These data were adjusted to the infiltration-capacities obtaining under natural rainfall conditions as determined from the analysis of 2 years of records on 11 plots in the Brown Loam near Holly Springs, Miss.[42] The final curves of infiltration-capacity gave average areal infiltration-capacities in close agreement with those obtained on the sample watersheds.

The infiltration-capacity curves were applied to three storm patterns representative of the average 1.5-, 3.0-, and 4.5-inch storms occurring in the area. The excess of rainfall, over and above the infiltration capacity for each complex making up each sample area, was summed up to determine the volume of surface run-off under present conditions. The same procedure was followed using the different areas characterized by the changed complexes to obtain the volume of surface run-off with the program in effect. The difference between the two volumes was the reduction used in computing the benefits.

[40] For a complete description of the methods used, see appendix, exhibit S.

[41] Two-thirds of the flood damage within the Little Tallahatchie watershed occurs on the minor tributary streams.

[42] An earlier study, the results of which were published June 1935 as U. S. Department of Agriculture Circular 347, Effect of Cover on Surface Run-off and Erosion in the Loessial Uplands of Mississippi.

FIGURE 9.

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Flood crests were obtained by establishing the relation between flood crest and volume, calculated from all recorded floods on the gaged sample areas. The curve expressing this relation was used to determine the flood crest for a given volume on each sample area for present as well as future conditions.

The durations of out-of-bank flow were taken directly from hydrographs. Using the all-floods-of-record average, hydrographs were obtained for single-peaked floods of various volumes, which showed duration at any depth for present flood volumes. Depth-duration-volume curves were prepared and entered with the reduced volumes effected by the program to obtain the corresponding durations.

The areas inundated for the various floods were derived from available data which included observed profiles for two actual floods, aerial photographs, and approximately 160 cross sections of the flood plain obtained by field surveys. From these data, curves of elevation at the gage versus area inundated to various depths were prepared. The same curves were used to obtain the areas inundated for the reduced flood volumes.

A sequence of flooding was established to obtain the reduction in flood volumes, crests, durations, and areas inundated, for the purpose of determining the flood-reduction benefits for the 10-year period. This sequence was derived from a 10-year record on the East Fork of Tombigbee River—the nearest comparable area with an unbroken record of stream flow. The basis for converting this record to volumes and sequence of flooding on the tributaries of the Little Tallahatchie was the 1½ years of concurrent records on the gaged tributaries of the Little Tallahatchie. The same flood sequence with the reduced flood volumes was used to calculate the flooding characteristics for the 10-year period with the recommended program in effect. All floods on each gaged area were grouped into five to eight volume classes, depending on the range in flood stages from zero flooding to the maximum.

Farmers were interviewed and information obtained on experienced flood damage to crops during the 10-year period 1929–38. Average annual damages to crops were developed from this information.

Since flood reductions and consequent benefits from the program will vary for floods of different sizes, it was necessary to determine the relationship between flood magnitude and damage. This was accomplished by developing flood damage factors by crops and by seasons, that is, rates of damage for different depths and durations of flooding. By applying those rates of damage as reflected in the normal series of floods selected for evaluation purposes to the total damages for the 10-year period 1929–38, it was possible to determine the amount of damage for each flood in the series. Similarly the crop damages were determined for this same series of floods as reduced in size by the program. In making these calculations adjustments were made in damages for the occurrence of more than one flood in the same crop year. Crop flood damages with and without the program in effect were computed as explained above for each of the sample tributaries and for the two main stream areas; the difference in damages thus obtained being taken as the benefits. A summary of those calculations is shown for one sample tributary, Cypress Creek (table 28).

TABLE 28.—*Average annual floodwater damage to crops in the Cypress Creek drainage basin*

Crop or land use	Present flooding conditions			Future flooding conditions under remedial program			Difference in damages, or flood control benefits
	Area	Per-acre damage	Total damage	Area	Per-acre damage	Total damage	
	Acres			*Acres*			
Cotton	160	$9.66	$1,545.60	135	$6.63	$901.68	$643.92
Corn	502	7.83	3,930.66	424	4.25	1,802.00	2,128.66
Hay	133	1.05	139.65	113	.63	71.19	68.46
Pasture	133	.25	33.25	111	.16	17.76	15.49
Idle	24			20			
Total	952		5,649.16	804		2,792.63	[1] 2,856.53

[1] Reduction in damages 50.6 percent.

Once determined by sample streams, the benefits were proportioned to the three major tributary areas, on the basis of benefits per acre of flooded land, correction being made for the extent of flooded bottom land and the extent of various land uses in the uplands (appendix, exhibits F and S).

Flood reductions for the main stems of the Little Tallahatchie River and Tippah Creek were calculated by the same method. In the latter computations, the reductions in volume, crest, and duration were determined at the reservoir high water line. To obtain reductions in areas inundated, cross sections and actual flood profiles were obtained for about 90 percent of the main stems. These data were expanded downstream to the reservoir high water line. The total flood-reduction benefits were obtained for each of the tributary areas by adding the minor-tributary benefits to the main-stem benefits.

Benefits from reduction in floodwater.—The remedial program will eliminate more than 25 percent (numerically) of the floods that now occur on the Little Tallahatchie streams. It will also reduce the flooded acreage by about 80 percent,[42a] computed from the weighted average reduction of inundated areas for all floods. This sizable reduction is accounted for by the elimination of the small floods, which inundate relatively large areas, and by the great reductions in the flooded acreage of the medium floods. Perhaps the best measure of the general effectiveness of the program is that floods occurring once a year on the average are lowered sufficiently to reduce the area now inundated by 36 percent. The acreages inundated under present conditions and those calculated for improved conditions are shown in table 29.

Expressed in terms of present worth, future flood control benefits from reduction in floodwater damage have an annual equivalent value of $137,721, of which $85,432 represents benefits in the Tallahatchie tributary area, $35,775 in the Tippah tributary area, and $16,514 in the reservoir tributary area.

[42a] This does not mean that 80 percent of the area now flooded will be free from future floods. Many areas that are now flooded several times each year will be flooded much less frequently and although floodwater may cover the same area in fewer floods, the aggregate area flooded will be much less.

TABLE 29.—*Expected reduction of inundated areas*

Actual occurrence in 10-year period[1]	Area of flooded land		Area of land protected from floods	Portion of flooded area that will be protected
	Present conditions	After remedial program		
	Acres	*Acres*	*Acres*	*Percent*
1	107, 684	78, 908	28, 776	27
11	97, 915	62, 389	35, 526	35
32	83, 120	43, 248	39, 872	44
63	63, 064	20, 771	42, 293	55
98	36, 562	2, 107	34, 455	69
114	23, 181	1, 463	21, 718	73
155	7, 711	0	7, 711	80

[1] Occurrence is the number of times in 10 years that flooded area equaled or exceeded the acreage shown

Sedimentation reduction and benefits.[43]

As previously indicated, sedimentation benefits from the recommended flood control program will be of three types, namely: (1) Reduction of the future net loss in productivity of flood-plain lands damaged by "deposition" and "swamping" (preventable future damage); (2) increased productivity of presently damaged flood-plain land (reclaimable past damage); and (3) reduced sediment damage to the Sardis Reservoir. Of these, benefits in the first category represent the major contribution the proposed program will make to sedimentation reductions, accounting for about 57 percent of the total sedimentation benefits.

Calculation of sedimentation benefits.—The calculations of diminished sedimentation for the 3 tributary areas were based on data taken on the Tallahatchie and Tippah main-stream flood plains and on the flood plains of 12 of their tributaries. These latter represent parts of the 4 physiographic areas and the 3 major tributary areas for which programs are developed and evaluated separately.

The rates of increase in the flood-plain acreage affected by sediment damage for all reaches of sample tributaries and main streams, when evaluated in terms of reduced gross productivity, permitted calculation of the net productive value of bottom lands in the three tributary areas, at present and 20 years hence, in 1960. This established an average rate at which the net productive value of the bottom lands is being reduced by deposition and swamping.

A primary assumption made in evaluating the benefits from prevention of future damage was that the rate of absolute increase of sediment damage is proportional to the rate at which excesses of sediment from uplands reach the bottoms. Accordingly, surveys were made to determine the rates of erosion (tons per acre per year) from the various upland land classes, and the expected rates of erosion that will occur under the conditions to which the land classes will be converted under the remedial program. These rates were corrected for sediment volumes deposited as colluvium. The annual decrease in net productivity caused by sediment was considered lessened each year in proportion to the reduction in the amount of sediment as a result of the program. The difference between the net productivity

[43] For complete information on the methods used to determine reductions in sedimentation, see appendix exhibit G.

each year in the future without and with the program represents the annual benefit derived from preventing sedimentation. These annual benefits become larger each year.

The productivity of flood plains damaged by past sedimentation can reasonably be expected to increase once the upland sediment-source areas are stabilized and harmful sediments are no longer deposited on the lowlands. This restoration of productivity will doubtless take place slowly through natural soil-building processes, but nevertheless represents a tangible benefit. Evaluation of the present reduced net productivity of damaged bottom lands and an estimate of the rate of natural improvement following reduced sedimentation provided a basis for calculating this type of benefit (appendix, exhibit G).

Benefits to the Sardis Reservoir will accrue from the recommended upstream program through savings effected by deferring the time at which expensive alterations of structures will be needed to offset reductions in flood storage capacity. As stated in chapter II, the annual cost of establishing a sinking fund of 4½ million dollars in 83 years (estimated length of time before alterations in structure necessary without a remedial program) amounts to $9,609.[44] Under the recommended program, however, the alterations would not be necessary for 214 years and the annual cost of establishing a 4½-million-dollar fund in that period amounts to only $94. Hence the benefits to the reservoir from the proposed remedial program amount to $9,515.

Benefits from reduced sedimentation.

The present value of monetary benefits computed for reduction of sediment damage in the watershed amounts to $132,461 annually. Of this total, $75,807 represents prevention of losses in net productivity of bottom-land soils, $47,139 represents reclamation of values lost through past sedimentation, and $9,515 represents benefits from reduction of sediment being deposited in the Sardis Reservoir.

Of the total sediment benefits evaluated, 45 percent is credited to the Tallahatchie tributary area, 23 percent to the Tippah tributary area, and 32 percent to the reservoir tributary area.

Benefits from more intensive use of the flood plain.

Reduced sedimentation and fewer overflows in the flood plains of the basin will permit more intensive use of flood-plain areas. Where frequent flooding now limits land use to woods, pasture, or hay crops, less frequent flooding in the future will permit the planting of cotton or corn on many areas. It is estimated that much of the flood plain will be benefited to the extent of $1 per acre annually, the total annual amount being approximately $80,000. Although this benefit is actual and measurable, it is not included with other benefits of the program because its use would require an adjustment in upland on-site benefits. This is true because farm organization and crop use is somewhat inflexible due to economic conditions and crop allotments under the Agricultural Adjustment Administration. The net benefit will be favorable although its measurement is not deemed essential.

[44] At rate of 3½ percent compounded annually.

Indirect benefits.

In addition to the benefits claimed from the reduction of floodwater damage, the reduction of sedimentation damage, and the reduction of siltation in the Sardis Reservoir, there will be indirect benefits resulting from the reduction in flood and sediment damage. Also, the enhancement in farm income realized because of reduced flood damage will increase the farmer's purchasing power and thereby improve general business conditions in the watershed. Higher cotton production will increase cotton ginning and related business activities. Interruptions to travel will be at a minimum when flood reductions are effected. Savings will be made by elimination of disease, sickness, and insect infestations that frequently follow the more severe floods. These indirect benefits, like the indirect damages from which they result, cannot be evaluated fully; it is conservatively estimated that they will amount to at least 25 percent of direct flood benefits, or $67,545 annually.

BENEFITS TO THE UPLANDS

The conservation or "on-site" benefits represent additional income to the owners of upland areas on which the flood-control program is applied and largely result from the soil- and water-conserving features of the remedial measures and the concomitant increased yields, smaller operating expenses, etc.

Determination of conservation benefits.[45]

By use of land classification data, field schedules, and Agricultural Adjustment Administration data, the number of farms and their composition, by acreages, organizational set-up, and economic factors, were determined for each physiographic area. With estimated abandonment rates,[46] it was possible to compute their income at a given future time as well as at present. Also, with estimated yield increases to accrue from the recommended treatment to existing land classes on these farms, it was possible to determine the income for a given future year under the remedial program. Normal farm prices [47] were used for all calculations of values.

Comparisons were then made between the future receipts and expenses with and without the program to determine average annual differences, based on interpolations of the yearly differences during the time required for the program to become effective plus the capitalized value of the ultimate annual difference. All yearly differences as well as the capitalized value of the ultimate amount were reduced to present worth, totaled, and then converted into average annual costs or benefits by multiplying this total by 3½ percent.

The same procedure was applied to the nonagricultural area in which Federal land acquisition is recommended, assuming a combination of public and private ownership with the program.

The average annual costs of installing and maintaining the program on farms and on wild land were next computed.

In the final calculation of costs and benefits, the costs were considered to include all expenses related to the installation and main-

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[45] For complete information on the methods used in determining conservation benefits, see appendix, exhibit N

[46] Abandonment rates consider the reduction in yields over the 20-year period as well as the land that is actually abandoned.

[47] As determined by the Farm Credit Administration.

tenance of the remedial measures, plus increased normal operating expenses, plus decreased gross receipts; benefits were considered as including all increases in gross receipts as well as decreases in normal operating expenses which might occur.

A final step involved proportioning costs and benefits on typical farms and units of nonagricultural land to the physiographic areas by simple expansion, then to tributary areas according to the proportional parts of physiographic areas within each tributary area.

Private conservation benefits.

The application and effects of the program are well illustrated on a typical medium-sized farm [48] in the agricultural area of the Pontotoc Ridge. At present, the farm has a total of 135 acres, of which 52 acres is cropland, 29 acres open and being used as pasture, 18 acres pastured woodland, 26 acres unpastured woodland, 4 acres abandoned land, and the remainder in farmstead, roads, and waste.

The gross income, including home-used products, is $1,005, with an operating cost (exclusive of unpaid family labor) of $526. This leaves a net farm income of $479. It is estimated on the basis of abandonment rates that several acres of cropland will be lost within 20 years, unless conservation measures are applied, reducing the net farm income to $457.

If the farmer cooperates in the proposed remedial program, his average annual costs will increase approximately $146 but his average annual benefits from these costs will increase approximately $268, a ratio of $1.83 of benefits per $1 of costs. His area of cropland will be increased, and his open pasture decreased slightly but improved to the point where the pasture-carrying capacity will be doubled. His woodland acreage will be protected from fire and grazing and placed under proper forest management.

With the program fully effective the farmer's gross receipts will average $1,342. Operating costs, plus annual maintenance of the conservation measures, will amount to $690, leaving a net income of $652, as compared with $457 without the program. This is a net increase of $1.44 per acre over and above the reduction in flood and sediment damage that will also benefit him if his farm is one of the 66 percent with damageable bottom land. It will take approximately 3 years for his annual cash income to equal or exceed the annual costs, but thereafter his annual profits will become increasingly larger.[49] Moreover, he will have the satisfaction of developing his farm as a permanent asset in contrast with frustration and liquidation of all resources.

The total private conservation benefits in the watershed will be slightly more than $680,000 annually, 59 percent occurring in the Tallahatchie tributary area, 20 percent in the Tippah tributary area, and 21 percent in the reservoir tributary area.

Public conservation benefits.

Public conservation benefits will accrue from forest management on Federal land and from the reduction of maintenance of Federal, State, and county roads.

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[48] This is not an actual farm, but the average for the medium-size class in this area.

[49] See appendix, exhibit P, for further information on the effect of the remedial measures on farm organization and income.

Increased yields on Federal forest land will result from the application of recommended measures and the monetary returns will be delayed for many years; even so, the present value of this benefit amounts to $83,832 annually.[50]

It is conservatively estimated that road-bank stabilization work will reduce annual maintenance costs by at least $50 per mile. On the 1,400 miles planned for this treatment, the public benefit will have an annual value of $61,218.

Thus, the total public conservation benefits will be $145,050 annually with 38 percent occurring in the Tallahatchie tributary area, 26 percent in the Tippah tributary area, and 36 percent in the reservoir tributary area.

Summary of benefits.

An evaluation of the proposed flood control program reveals that the recommended measures will produce benefits with an average annual value of $1,162,861. Of this total $337,727 or 29 percent represents the direct and indirect flood control benefits that will result from the reduction of floodwater and sedimentation damage on the bottom lands through the application of the recommended measures on the uplands.[51] The remainder of $825,134 or 71 percent represents the on-site or conservation benefits that will result from increased production on the upland areas to which the measures are applied (table 30).

TABLE 30.—*Average annual monetary benefits from the recommended flood-control program, Little Tallahatchie watershed*

Tributary area and class of benefit	Average annual benefits [1]		
	Public [2]	Private	Total
Tallahatchie:			
Reduction of floodwater damage	$85, 432		$85, 432
Prevention of harmful sedimentation	42, 883		42, 883
Alleviation of past sediment damage	13, 704		13, 704
Prevention siltation in Sardis Reservoir	3, 074		3, 074
Total direct flood-control benefits	145, 093		145, 093
Indirect flood-control benefits	36, 273		36, 273
Conservation (on-site) benefits	54, 315	$406, 510	460, 825
All monetary benefits	235, 681	406, 510	642, 191
Tippah:			
Reduction of floodwater damage	35, 775		35, 775
Prevention of harmful sedimentation	18, 620		18, 620
Alleviation of past sediment damage	10, 625		10, 625
Prevention siltation in Sardis Reservoir	681		681
Total direct flood-control benefits	65, 701		65, 701
Indirect flood-control benefits	16, 425		16, 425
Conservation (on-site) benefits	38, 066	133, 754	171, 820
All monetary benefits	120, 192	133, 754	253, 946

[1] Obtained by reducing all benefits to their present value equivalent and multiplying by 3½ percent.
[2] Public benefits include all flood-control benefits plus all on-site benefits accruing to the public owners of land now or to be in public ownership.

[50] See appendix, exhibit R, for determination of on-site yields on forest land.
[51] These benefits are distributed as follows: Benefits from reduction of floodwater damage to crops, farm property, roads, bridges, and railroads, $156,913; benefits from reduction of siltation of Sardis Reservoir, $9,515; benefits from reduction of rates of sedimentation damage on productive land, $91,008; and indirect benefits, $65,995.

TABLE 30.—*Average annual monetary benefits from the recommended flood-control program, Little Tallahatchie watershed*—Continued

Tributary area and class of benefit	Average annual benefits		
	Public	Private	Total
Reservoir:			
Reduction of floodwater damage	$16,514		$16,514
Prevention of harmful sedimentation	14,304		14,304
Alleviation of past sediment damage	22,810		22,810
Prevention siltation in Sardis Reservoir	5,760		5,760
Total direct flood-control benefits	59,388		59,388
Indirect flood-control benefits	14,847		14,847
Conservation (on-site) benefits	52,669	$139,820	192,489
All monetary benefits	126,904	139,820	266,724
All areas:			
Reduction of floodwater damage	137,721		137,721
Prevention of harmful sedimentation	75,807		75,807
Alleviation of past sediment damage	47,139		47,139
Prevention siltation in Sardis Reservoir	9,515		9,515
Total direct flood-control benefits	270,182		270,182
Indirect flood-control benefits	67,545		67,545
Conservation (on-site) benefits	145,050	680,084	825,134
All monetary benefits	482,777	680,084	1,162,861

Benefits from the proposed program will begin to accrue almost immediately; sizable reductions in floodwater damage will be realized in 5 to 10 years as the fire protection system becomes well established, and the major part of the flood reduction benefits will accrue within 20 to 30 years after treatment. When the program is fully effective, average annual floodwater damage will be reduced from about $343,000 to about $108,000 or slightly more than 68 percent.

The private conservation benefits will result from increased farm income brought about by a stabilized and diversified farm economy. While these benefits will have a value of $680,084 annually, they have no direct bearing on the justification for spending Federal funds for flood-control purposes. However, they will materially influence farmer participation in the program. If landowners are not assured of substantial benefits, it is doubtful if much favorable response to the program can be obtained. The estimated conservation benefits, plus the virtual assurance of a continued existence for agriculture, will play an important part in obtaining the cooperation necessary to make the proposed measures effective.

In addition to these private benefits, the long-time management, as well as the development and restoration of the productiveness, of nonagricultural land undertaken by Government agencies will result in comparable general public benefits totaling $145,050 annually. These benefits will come largely from the application of expensive measures with delayed returns—measures that cannot be economically undertaken by private owners on land that is unprofitable in its present physical condition under any form of private management.

Over and above both the flood-control and conservation benefits mentioned above, there will be certain other benefits which, although not readily susceptible to detailed analysis and monetary evaluation, will significantly influence and affect the future well-being of the inhabitants of the watershed.

One of the most important of these benefits will be the stabilization of local industry brought about by the merchantable timber that will be currently available in quantity for purchase and manufacture by the public, once the nonagricultural lands are again brought into full productivity. It is estimated that the national forest lands, in addition to the timber, will provide 243,000 man-days of employment annually when the program is fully effective (appendix, exhibit Q).

Recreational possibilities will be greatly enhanced by the development of cover and feed for wildlife and the reduction of siltation in streams and in the Sardis Reservoir. Recreational values of the Sardis Reservoir are already widely enjoyed and will continue to increase with the control of sedimentation. Without control, the permanent pool may eventually be a mud or sand flat.

Development of pastures and subsequent additions to the number of dairy and beef cattle will encourage growth of the dairy industry. Other phases of the agricultural program will likewise encourage much-needed industrial development in the watershed.

Chapter VII.—Comparison of Costs and Benefits

ANNUAL COSTS [52]

The average annual equivalent of the costs of the proposed flood-control program is $464,526, of which $153,015 will be charged to public funds, while $311,511 represents the cost to private interests (table 31).

Table 31.—*Average annual costs of the flood control remedial program*

Item	Tributary area			Total watershed
	Tallahatchie	Tippah	Reservoir	
Federal costs	$51,068	$28,319	$58,708	$138,095
State and local government costs	8,398	2,302	4,220	14,920
Private costs	188,197	56,855	66,459	311,511
Total annual costs	247,663	87,476	129,387	464,272

The average annual Federal costs necessary for installation of the program amount to $107,464. Federal maintenance costs, amounting to $30,631, provide maintenance for the fire-protection system and the technical supervision and administration required. The only expense charged to State and local agencies is the partial cost of roadbank stabilization. Private costs, having an annual value of $30,441 for installation and $281,070 for operation and maintenance, include increased farm operating expenses and any temporary decrease in private receipts, as well as the private installation and maintenance costs of the program.

[52] Previous references to costs of the program in ch. V have been on an investment basis, i. e., the total expense or appropriation needs regardless of the time element. To compare costs with benefits, however, it is necessary to show both on the basis of their present annual value. This is accomplished by: (1) Carrying both benefits and costs to a point in the future (varying by measures) where they level off, then capitalizing and discounting them to present value; (2) adding the discounted, present-worth value of all nonuniform annual benefits and costs prior to the time they level off; and (3) reducing the sum of all discounted values to any appropriate annual equivalent by multiplying by an appropriate interest rate (in this instance, 3½ percent.

COST-BENEFIT RATIOS

The proposed flood control-program in the Little Tallahatchie watershed will yield $2.50 of benefits for every dollar spent (table 32). The expenditure of each dollar of Federal money will yield $2.45 of benefit in the reduction of flood and sediment damage.

TABLE 32.—*Comparison of average annual costs and benefits of the recommended flood-control program*

Item	Tributary area			Total watershed
	Tallahatchie	Tippah	Reservoir	
Federal cost	$51,068.00	$28,319.00	$58,708.00	$138,095.00
Flood reduction benefits	181,366.00	82,126.00	74,235.00	337,727.00
Benefits per dollar of cost	3.55	2.90	1.26	2.45
Total program costs	247,663.00	87,476.00	129,387.00	464,526.00
Total program benefits	642,191.00	253,946.00	266,724.00	1,162,861.00
Benefits per dollar of cost	2.59	2.90	2.06	2.50

For every dollar the farmer puts into the proposed program he will receive on the average $2.18 return from conservation benefits through increased net farm income. In addition, about two-thirds of the farmers will be the recipients of a portion of the public benefits in the form of reduced flood and sediment damages; on a basis of all farmers sharing in these public benefits, it will amount to $3 of benefit per dollar of costs. In all tributary areas, benefits exceed costs; thus the proposed program is economically sound and cooperators will receive ample benefits to warrant their participation.